Staff Report for the Action Plan for the Scott River Watershed Sediment and Temperature Total Maximum Daily Loads

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EXECUTIVE SUMMARY

This document is the Staff Report that supports and explains the Action Plan for the Scott River Watershed Sediment and Temperature Total Maximum Daily Loads (Scott River TMDL Action Plan). The Scott River TMDL Action Plan is proposed as an amendment to the Basin Plan.

The Scott River watershed comprises approximately 520,184 acres (813 mi^2) in Siskiyou County, California. The Scott River is tributary to the Klamath River.

Section 303(d) of the Clean Water Act requires states to compile a list of impaired water bodies that do not meet water quality standards. The Clean Water Act also requires states to establish total maximum daily loads (TMDLs) for such waters. The Scott River is listed under Section 303(d) as impaired by elevated sediment levels and elevated water temperatures. Adoption and approval of the Scott River TMDL Action Plan will establish the TMDLs and will satisfy the requirements of Section 303(d). The goal of the Scott River TMDL Action Plan is to achieve the TMDLs, achieve sediment and temperature water quality standards, and protect the beneficial uses of water in the Scott River watershed.

Excessive sediment loads and elevated water temperatures have impaired many designated beneficial uses of the Scott River and its tributaries. Several of the primary beneficial uses impaired are those uses associated with the cold water salmonid fishery. Salmonid populations in the Scott River watershed have declined significantly from historic levels and coho salmon are listed as threatened under the state and federal Endangered Species Acts. Excessive sediment loads and elevated water temperatures have resulted in the non-attainment of water quality objectives for sediment, suspended material, settleable material, and water temperature.

In regards to excessive sediment loads:

- Available data on instream sediment conditions in the mainstem Scott River through Scott Valley show a consistent pattern of sediment impairment, though with indications of improving trends for some parameters.
- Available data on instream sediment conditions in Shackleford-Mill, Etna, French, and Sugar creeks show mixed conditions, with some parameters exceeding desired conditions, some meeting desired conditions, and some with stable or improving trends in fine sediment values.
- Available data on instream sediment conditions in Tompkins, Boulder, and Canyon creeks generally indicate sediment impairment.

In regards to elevated water temperatures:

- Summer temperature conditions do not support suitable salmonid rearing habitat in the mainstem of the Scott River and the East Fork of the Scott River.
- Summer temperature conditions do not support suitable salmonid rearing habitat in the lower reaches of Kelsey, Shackleford, Kidder, Patterson (west side), French, Wildcat, Etna, and Big Carmen creeks and the upper reaches of Moffett Creek and Sissel Gulch.

The sediment source analysis identifies the various sediment delivery processes and sources in the Scott River watershed and estimates delivery from these sources. Sources include landslides, large and small discrete streamside features, soil creep, and roads. The largest human-caused sediment sources are from streamsides and are the result of multiple interacting human activities. Results also show that the current sediment delivery is 167% of the natural sediment delivery in the Scott River watershed. The sediment TMDL is set at 125% of natural sediment delivery, which equals 560 tons of sediment per square mile per year.

The temperature source analysis identifies the various water heating and cooling processes and sources of elevated water temperatures in the Scott River watershed. The source analysis found that the primary human-caused factor affecting stream temperatures is increased solar radiation resulting from reductions of shade provided by vegetation. Groundwater inflows are also a primary driver of stream temperatures in the Scott Valley. Diversions of surface water lead to relatively small temperature impacts in the mainstem Scott River, but have the potential to affect temperatures in smaller tributaries, where the volume of water diverted is large relative to the total flow. Microclimate alterations also have the potential to impact stream temperatures.

The temperature TMDL for the Scott River watershed is the "adjusted potential effective shade" conditions (as defined in the Glossary) for the date of the summer solstice. The temperature TMDL is focused on the heat loads that arise from changes in shade and streamside vegetation. Other controllable factors influenced by human activities (i.e., changes in stream flow, microclimates, and channel geometry) are not included in the TMDL at this time, due to lack of information.

In order to attain the sediment and temperature TMDLs, achieve the sediment and temperature related water quality standards, and protect the beneficial uses of water in the Scott River watershed, specific implementation actions need to be taken. The implementation actions are designed to encourage and build upon on-going, proactive restoration and enhancement efforts, and to comply with the state's *Policy for the Implementation and Enforcement of the Nonpoint Source Pollution Control Program.* Should any of the implementation actions fail to be implemented by the responsible party or should the implementation actions prove to be inadequate, the Regional Water Board shall take appropriate permitting and/or enforcement actions.

The implementation actions address:

- sediment waste discharges;
- roads at the private, county, and state levels;
- ground-disturbing activities;
- dredge mining;
- water temperature and vegetation;
- water use;
- flood control and bank stabilization;
- timber harvest;
- activities on U.S. Forest Service land;
- activities on U.S. Bureau of Land Management land;
- grazing; and

- cooperation with the Siskiyou Resource Conservation District, Scott River Watershed Council, Natural Resources Conservation District, University of California Cooperative Extension and California Department of Fish and Game.

Monitoring is necessary to determine if implementation actions are being undertaken, if TMDLs are being attained, if water quality objectives are being met, and if beneficial uses are being protected. Monitoring (e.g., implementation monitoring, upslope effectiveness monitoring, instream effectiveness monitoring, and compliance and trend monitoring) may be required in conjunction with existing and/or proposed human activities that will likely result in sediment waste discharges or elevated water temperatures. Additionally, Regional Water Board staff shall develop a compliance and trend monitoring plan within one year of the date the Scott River TMDL Action Plan takes effect.

Reassessment is necessary for the long-term success of the Scott River TMDL Action Plan. The Regional Water Board will conduct an extensive and focused reassessment after the Scott River TMDL Action Plan has been in effect for ten years, or sooner, if the Regional Water Board determines it necessary. Regional Water Board staff will report to the Regional Water Board at least yearly on the status and progress of implementation actions. For actions that rely on encouragement of existing efforts that address water quality impairments, the Regional Water Board will conduct a formal assessment of the proven or expected effectiveness of these efforts within five years of approval of the TMDL Action Plan.

This Staff Report, the Scott River TMDL Action Plan, and the adoption and approval process are fully compliant with the California Environmental Quality Act (CEQA). The adoption of the Scott River TMDL Action Plan will not have a significant adverse impact on the environment.

Because the Scott River TMDL Action Plan relies on encouragement of existing efforts and on existing water quality regulation, adoption of the Action Plan will not have any incremental economic impacts. Economic impacts of existing water quality regulations addressing sediment and temperature impairments are presented in this report for informational purposes. Positive economic impacts of complying with existing water quality regulations include benefits related to fishing, flooding, properly functioning ecosystems, recreation, remediation activities, residential land prices, and water conveyance and storage facilities. Negative economic impacts of complying with existing water quality regulations include costs related to roads and sediment waste discharges, dredge mining implementation actions, temperature and vegetation implementation actions, water use implementation actions, flood control and bank stabilization actions, implementation actions for the United States Forest Service and the Bureau of Land Management, and grazing implementation actions. The estimated costs of complying with existing water quality regulation can be justified because of economic benefits and legal obligations to protect water quality and beneficial uses.

The public has had many opportunities to comment on and participate in the development of the Scott River TMDL Action Plan and this Staff Report. The Scott River TMDL Technical Advisory Group (TAG) has provided input and advice to Regional Water Board staff. Staff have responded to many comments and questions raised by the TAG. A public scoping meeting was held to solicit public comments. Status updates and presentations have been made to the

Regional Water Board and members of the public. There will be many more opportunities for public input and comment throughout the adoption and approval process.

CHAPTER 1. INTRODUCTION

Key Points

- This document is the Staff Report that supports and explains the Scott River TMDL Action Plan. The Scott River TMDL Action Plan is proposed as an amendment to the Basin Plan.
- Section 303(d) of the Clean Water Act requires states to compile a list of impaired water bodies that do not meet water quality standards. The Clean Water Act also requires states to establish total maximum daily loads (TMDLs) for such waters.
- The Scott River is listed under Section 303(d) as impaired by elevated sediment levels and elevated water temperatures.
- The goal of the Scott River TMDL Action Plan is to achieve the TMDLs, achieve sediment and temperature water quality standards, and protect the beneficial uses of water in the Scott River watershed.
- Throughout the Scott River watershed, many individuals, groups, and agencies have been working to restore and enhance fish habitat and water quality. Joint projects of the Siskiyou County Resource Conservation District and the Scott River Watershed Council alone have implemented 132 restoration projects. A total of $9.3 million have been received from a variety of mostly public funding sources to implement these projects between 1992 and March 2005.
- The Scott River watershed is a unique place, characterized by its geography, population, climate, topography, vegetation, hydrology, geology, history, and land use.

1.1 DOCUMENT STRUCTURE & CONTENTS

1.1.1 Scott River TMDL Action Plan

The Scott River TMDL is comprised of two distinct parts: the Staff Report and the TMDL Action Plan. This document is the Staff Report that supports and explains the TMDL Action Plan. Specifically, this document contains the following information:

- Background information.
- Justification and rationale for the amendment.
- Source analyses and methodologies.
- TMDLs and supporting technical information.

- Load allocations and supporting technical information.
- Implementation strategy.
- Monitoring plan.
- Reassessment strategy.
- Economic analysis.
- Alternatives and recommendations of staff of the Regional Water Board.
- Appropriate CEQA documentation.

The full title of the TMDL Action Plan is the *Action Plan for the Scott River Sediment and Temperature Total Maximum Daily Loads*. The Scott River TMDL Action Plan includes the sediment and temperature TMDLs, the strategy to achieve the TMDLs and water quality standards, and draws upon the information presented in the Staff Report. Thus, the support, justification, and technical analysis upon which the Scott River TMDL Action Plan is based can be found in this Staff Report. The Scott River TMDL Action plan is proposed as an amendment to the *Water Quality Control Plan for the North Coast Region* (the Basin Plan) for adoption by the North Coast Regional Water Quality Control Board (Regional Water Board) and the State Water Resources Control Board (State Water Board).

1.1.2 TMDL Introductory Language

As part of the Basin Plan amendment for the Scott River TMDL Action Plan, Regional Water Board staff also propose to add an introduction of TMDLs to the Basin Plan. The additional amendment language contains an introduction to TMDLs, TMDL Action Plans, and the policies and regulatory tools that are applicable to TMDLs.

The additional amendment language is intended to be inserted into the implementation chapter of the Basin Plan. Specific TMDL action plans, such as the Scott River TMDL Action Plan, will then follow this introductory language and be arranged alphabetically by water body.

The purpose for adding the TMDL introductory language into the Basin Plan is to increase the reader's understanding of TMDLs and TMDL action plans. To that end, the language includes a description of the federal requirements for TMDLs and definitions of TMDLs and TMDL action plans. The policies included in the overview are as follows:

- The *Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options* (the Impaired Waters Policy).
- The *Policy for the Implementation and Enforcement of the Nonpoint Source Pollution Control Program* (the NPS Policy).
- The *Total Maximum Daily Load Implementation Policy Statement for Sediment-Impaired Receiving Waters in the North Coast Region* (the Sediment TMDL Implementation Policy).

The TMDL introductory language also includes an overview of statewide and regional policies that affect TMDLs and the permitting and enforcement tools that can be used in TMDL implementation.

1.2 RATIONALE

The Scott River Total Maximum Daily Loads (TMDLs) for Sediment and Temperature are being established in accordance with Section 303(d) of the Clean Water Act. The State of California has determined that the water quality standards for the Scott River are exceeded due to excessive sediment and elevated water temperature. In accordance with Section 303(d), the State of California periodically identifies those waters that are not meeting water quality standards. The United States Environmental Protection Agency (USEPA) added the Scott River to California's 303(d) impaired waters list in 1992 due to elevated sediment levels and in 1998 due to elevated water temperatures. The Scott River has continued to be identified as impaired in subsequent listing cycles, the latest in 2002.

Excessive sediment loads and elevated water temperatures in the Scott River and its tributaries have resulted in the impairment of designated beneficial uses of water and the non-attainment of water quality objectives. The primary beneficial uses impaired in the Scott River watershed are recreation uses (i.e., contact and non-contact recreation) and those associated with the cold water salmonid fishery (i.e., commercial and sport fishing; cold freshwater habitat; rare, threatened, and endangered species; migration of aquatic organisms; and spawning, reproduction, and/or early development of fish). The cold water fishery beneficial uses include the migration, spawning, reproduction, and early development of cold water fish such as coho salmon (*Oncorhynchus kisutch*), chinook salmon (*O. tshawytscha*), and steelhead trout (*O. mykiss*). The coho salmon population in this watershed is listed as threatened under the federal Endangered Species Act and the California Endangered Species Act. Agricultural and municipal water supplies and groundwater recharge are also affected by excessive sediment supply.

1.3 PURPOSE AND GOALS

The purpose of the Scott River Sediment and Temperature TMDLs is to estimate the assimilative capacity of the system by identifying the total loads of sediment and thermal inputs that can be delivered to the Scott River and its tributaries without causing exceedence of water quality standards. The TMDLs also allocate the total loads among the sources of sediment and thermal loading in the watershed. Although factors other than excessive sediment and elevated stream temperature in the watershed may be affecting salmonid populations (e.g., ocean rearing conditions), these TMDLs focus on sediment and stream temperature conditions in the watershed, the impairments for which the Scott River is listed under Section 303(d).

The goal of the Scott River TMDL Action Plan is to achieve the TMDLs, achieve sediment- and temperature-related water quality standards, and protect the beneficial uses of water in the Scott River watershed. The TMDL Action Plan applies to the portions of the Scott River watershed governed by California water quality standards. It does not apply to lands under tribal jurisdiction.

1.4 WATERSHED RESTORATION AND ENHANCEMENT EFFORTS

Throughout the Scott River watershed, many individuals, groups, and agencies have been working to enhance and restore fish habitat and water quality. These proactive efforts have given the Scott River watershed an advantage over other impaired watersheds with less active stakeholders. The implementation actions described in this document (Chapter 5) reflect the good work and watershed restoration efforts within the Scott River watershed. The Regional Water Board and staff look forward to the improved water quality conditions that are likely to result from the continued implementation of these public, private, and often voluntary programs.

The following sections describe some of the proactive and beneficial accomplishments of concerned citizens and agencies within the Scott River watershed to address sediment waste discharges and elevated water temperatures.

1.4.1 Siskiyou Resource Conservation District

The Siskiyou Resource Conservation District (SRCD), like other resource conservation districts, is a local unit of government established to carry out natural resource management programs. The SRCD was established in 1949 and seeks funding to implement conservation/restoration projects of willing landowners and provides technical assistance throughout the Scott River watershed, especially to landowners involved with agriculture in the Scott Valley. The restoration and enhancement efforts that the SRCD has been involved with over the years relied on the voluntary participation of private agricultural and timber landowners and grant funding.

1.4.2 Scott River Watershed Council

With fiscal and project management assistance from the SRCD, the Scott River Watershed Council (SRWC) has also been making significant strides in the restoration and management of the Scott River and its tributaries. The SRWC was formerly known as the Scott River Watershed Coordinated Resource Management Planning (CRMP) Committee, which formed in September 1992. The goal of the SRWC is to “Seek coordinated resource management in the Scott River watershed which will produce and maintain a healthy and productive watershed and community” (SRWC, 2004, p. 1-3). The SRWC focuses on the diverse group of landowners and land use activities throughout the Scott River watershed. The community-based nature of the SRWC, their accomplishments to date, their technical knowledge, their established history in the watershed, and the trust they have established with a diverse group of interested individuals and community members make the SRWC an ideal group to help implement sediment and temperature control practices.

In 2004, the SRWC completed the Scott River Watershed Strategic Action Plan, which forms the basis for setting priorities for future projects and management practices. The Strategic Action Plan builds upon the first action plans developed by the CRMP in 1995, which addressed fall flows and fish habitat and populations. Many of the strategic actions identified in their plan will be of direct benefit to water quality in the Scott River watershed and will address sediment waste discharges and elevated water temperatures. See Section 5.1.10 for more information on the Strategic Action Plan.

The SRWC has also developed a monitoring plan, which is included as an appendix in the Strategic Action Plan. The monitoring plan provides definitions, methods, and protocols for various monitoring efforts. Methodologies have been established for the monitoring of fish habitat; fish populations; channel conditions through bank stability surveys and channel typing; water temperature; flow; instream sediment levels through V* measurements, McNeil sampling, pebble counts, and turbidity sampling; macroinvertebrate populations; riparian conditions through photo-point monitoring; and restoration project effectiveness through photo-point monitoring. The SRWC also intends to establish and carry out quality assurance and quality control procedures, establish a monitoring database, analyze data, and report on conditions.

1.4.3 Joint Projects of the Siskiyou Resource Conservation District and the Scott River Watershed Council

Since 1992, the SRCD and the SRWC (formerly the CRMP) together have been involved in developing and implementing many significant and beneficial water quality projects. Between 1992 and March 2005, "a total of 132 projects have been implemented on private lands. A total of $9.3 million dollars have been received from various funding sources and invested into the Scott River Watershed to implement these projects" (SRCD, 2005a, p.1). As listed in the Strategic Action Plan (SRWC, 2004) and documentation provided by the SRCD (SRCD, 2005a; SRCD, 2005b), some of these projects include:

- <u>Riparian fencing, riparian planting, bank stabilization, habitat improvement, and stockwater systems installation projects.</u> As a result of many of these projects, riparian exclusionary fencing is in place along ninety-five percent of the mainstem Scott River (cattle are not present in the remaining five percent) and along forty percent of the tributaries. Approximately 200 acres of riparian zone has been planted with pine, cottonwood, and willow. There are several projects, including the following:
    - Scott River Riparian Restoration Analysis,
    - French Creek Riparian Protection and Enhancement Project,
    - Patterson Creek Enhancement Project,
    - Lower Kidder Creek Enhancement Project,
    - Landowner Riparian Planting and Fencing Project,
    - Shackleford Creek Demonstration Project,
    - Scott River Landowner Riparian Restoration Project,
    - Fowle Maintenance Project,
    - East Fork Scott River Habitat Improvement Project,
    - Shackleford Creek Restoration Project,
    - Fay Lane Restoration Project,
    - Shackleford/Mill Road Corridor Improvement Project,
    - Scott River Corridor Habitat Improvement Project located at Eiler Ranch,
    - Scott River Streambank Protection & Riparian Fencing Project at Tozier Ranch,
    - Scott River Riparian Restoration Project,
    - Scott River Riparian Fencing & Planting Project,
    - Scott River Riparian Woodland Revegetation Project,
    - Scott River Corridor Enhancement Project,

- Scott River Streambank Protection Project, and
- Scott River Riparian Zone Inventory and Evaluation (Alvin Lewis Study).

- Instream salmonid habitat improvement projects. As a result of these projects, over 317 instream structures have been installed on private property. There are several projects, including the following:
  - Aquatic Habitat Needs Study Plan,
  - Diversion Improvement Program through the use of wiers,
  - Canyon Creek Spawning Gravel Development Project, and
  - Upper Ruffey Lake Habitat Improvement Project.

- Sediment waste discharge studies and reduction projects. As a result of these projects, over 400 miles of roads have been inventoried, approximately 127 miles of roads have received erosion and sediment control improvements (e.g., outsloping, culvert removal, and rocking), and over nineteen miles of roads have been decommissioned. There are several projects, including the following:
  - Moffett Creek Road Abandonment and Decommissioning Project,
  - Moffett Creek Upland Gross Assessment,
  - Mill Creek Road Erosion Inventory,
  - Etna Road Erosion Inventory,
  - South Fork Road Erosion Reduction Project,
  - Shackleford/Mill Road Erosion Reduction Project, and
  - Shackleford/Mill Road Erosion Inventory.

- Flow studies, flow gauging, flow enhancement, tailwater return, and water conservation projects. There are several projects, including the following:
  - Farmers Ditch Diversion Improvement Project,
  - Shackleford Creek Diversion Improvement Project
  - Scott River and Major Tributaries Instream Flow Analysis,
  - Scott River Water Trust Program,
  - Wolford Slough Groundwater Retention Project,
  - Sugar Creek Flow Enhancement Project,
  - Scott River Monitoring/Gauging Project,
  - Shackleford/Mill Water Quality Improvement Project,
  - Scott River Water Conservation-Irrigation Management Project,
  - Scott River Water Balance Study,
  - Scott River USFS Station Operation for FY 1996,
  - Scott River Flow Enhancement Project, and
  - completion of the *Assessment of Scott River Water Trust Options* by Robert Donlan (2004).

- Education projects that focused on watershed and salmonid protection. There are several projects, including the following:
  - Etna Union High School District Watershed Education Program,
  - UC Davis Workshop,
  - Salmon Education Community Workshop, and

    - Kidder Creek Environmental School Fish Field Study Program.

- Monitoring projects. As a result of these projects, water temperature data has been collected since 1995, macroinvertebrate data has been collected since 1998, and three years of adult coho spawning data have been collected. There are several projects, including the following:
    - Scott River Out-Migrant Trapping Project,
    - Mid-Klamath River Chinook Spawner Escapement Survey,
    - Scott River Coho Spawning Assessment
    - Scott River Adult Coho Spawning Ground Survey,
    - Scott River Juvenile Coho Summer Habitat Utilization Survey,
    - Scott River Monitoring Program,
    - Scott River Temperature Assessment, and
    - Temperature Monitoring Program.
- Fish screening and fish passage projects.
- Spawning surveys and studies of salmonid habitat.
- Development of the Strategic Action Plan.

1.4.4 French Creek Watershed Advisory Group

The French Creek Watershed Advisory Group (WAG) was formed in 1990 at the urging of the State Board of Forestry to address cumulative watershed effects and road-related discharges of sediment waste. The French Creek WAG consists of a diverse group of participants, including the Audubon Society, Siskiyou County, CDFG, California Department of Forestry and Fire Protection, the French Creek Drainage Property Owners' Association, Fruit Grower's Supply Company, the Klamath Ecosystem Restoration Office, the Regional Water Board, the SRCD, the SRWC, Roseburg Resources Company, Sierra Pacific Timber Products, the USFS, and the Natural Resources Conservation Service. The French Creek WAG targeted major road-related sediment sources and monitored the changes in French Creek. The SRWC's Strategic Action Plan describes some of the French Creek WAG's efforts:

> "To reduce the sediment yield in the drainage, the French Creek Watershed Road Management Plan and Monitoring Plan were prepared and adopted by the group in late 1992. Much effort was spent on improving the existing road systems on all ownerships in the watershed during the next few years, such as out-sloping, rocking 34 miles of unsurfaced roads, and correcting drainage problems. Monitoring results – such as the amount of fine sediment in pools – began to show immediate improvement in stream habitat quality and sediment levels lowered to within natural background levels by 1995. In 1996, the French Creek group received the CF Industries / Conservation Fund National Watershed Award for voluntary initiatives due to its documented collaborative success. After the 1997 flood, sediment levels in pools increased somewhat but returned to pre-flood, background levels by 1999 and have been sustained since then" (SRWC, 2004, p. 10-7).

1.4.5 Industrial Timber Companies

Private timber companies within the Scott River watershed have also been actively taking steps to protect water quality. The two largest industrial timberland owners in the watershed are Fruit Grower's Supply Company and Timber Products Corporation. Both of these companies have inventoried sediment waste discharges associated with their roads and taken steps to control these sources. These steps include road upgrades, road outsloping, and moving roads away from near-stream areas.

Fruit Grower's Supply Company is also in the process of developing a habitat conservation plan (HCP) that will be designed to protect endangered and threatened species, including coho salmon. The HCP will address timber harvest activities, roads, hillslope practices, and riparian management practices. This proactive step will improve water quality in the Scott River watershed.

1.4.6 Siskiyou County Department of Public Works & Five Counties Salmon Conservation Program

Siskiyou County's Department of Public Works (DPW) is responsible for the management of county roads and bridges in the Scott River watershed. The DPW is an active participant in the Five Counties Salmonid Conservation Program.

Five counties in northern California – Siskiyou, Del Norte, Humboldt, Trinity, and Mendocino – have joined together in the Five Counties Salmonid Conservation Program(Harris, 2002). The Five Counties program is a joint project of the University of California, Cooperative Extension and the five counties in response to the listing of coho salmon under the federal Endangered Species Act. The Five Counties Salmonid Conservation Program developed *A Water Quality and Stream Habitat Protection Manual for County Road Maintenance in Northwestern California Watersheds* (2002). "The purpose of this manual is to provide a user-friendly, fish-friendly guide for County road maintenance staff as part of each county's primary mission to provide a safe and open road system for the traveling public" (Five Counties Salmonid Conservation Program, 2002, p. vi).

Through the Five Counties Salmon Conservation Program, the Siskiyou County DPW has received training on the manual and sediment control practices designed specifically for county roads. Additionally, Siskiyou County will soon have a road sediment source inventory performed through the Five County program. This inventory will describe the potential of county roads to delivery sediment waste to streams and sets priorities for treatment, using a protocol known as Direct Inventory of Roads and Treatments (DIRT). This program includes an inventory methodology, guidance, and a database for storing and analyzing the data.

1.4.7 CDFG Coho Recovery Process and Incidental Take Permits

As a result of the listing of coho salmon as threatened in the Scott River under the California Endangered Species Act, the California Department of Fish and Game (CDFG) developed a statewide *Recovery Strategy for California Coho Salmon* (Coho Recovery Strategy) that includes an important section on just the Scott and Shasta rivers. The Coho Recovery Strategy was developed with significant input from stakeholders who live and work in the Scott or Shasta watersheds.

The Coho Recovery Strategy includes implementation actions and recommendations for the recovery of coho salmon. Several of the actions that are relevant to the sediment and temperature water quality impairments in the Scott River watershed are listed in Table 5.5 and discussed in Section 5.1.12.3. For example, there are actions and recommendations relating to riparian vegetation, sediment inputs, roads, water use, groundwater, and the dredge tailings.

The California Endangered Species Act also prohibits the take of a threatened species without authorization, which is known as an Incidental Take Permit. CDFG and the SRCD are currently working on a watershed-wide permitting approach. Under the Watershed-wide Incidental Take Permit, the SRCD will be the permit holder allowing individual landowners in the watershed (primarily those involved with agricultural water diversion and/or livestock management activities) to enroll as sub-permittees in the program and work directly with the SRCD. The sub-permittees would avoid a CDFG fee and be protected from enforcement action under the Endangered Species Act. Salmonid research and restoration projects also fall under the scope of the Watershed-wide Incidental Take Permit. See Section 5.1.12.4 for more information on the Incidental Take Permit.

1.4.8 Department of Water Resources

The California Department of Water Resources (DWR) assists local water districts in water management and conservation activities and plans for future statewide water needs. In the Scott River watershed, the DWR has been involved with the installation of stream gages, rescues of stranded salmonids, and the development of the Coho Recovery Strategy. The DWR has also increased coordination efforts with other agencies involved in water management issues in the Scott River watershed.

1.4.9 United States Forest Service

Efforts by the United States Forest Service (USFS) to enhance and restore water quality in the Scott River watershed have included both planning and on-the-ground implementation projects. In regards to planning efforts, the USFS has developed two ecosystem analyses for the Scott River watershed: the Callahan Ecosystem Analysis in 1997 and the Lower Scott Ecosystem Analysis in 2000. The purpose of the analyses is to provide a means by which the watershed can be understood as an ecological system and to develop and document an understanding of the processes and interactions occurring within the ecosystem (USFS, 1997). The analyses also include the management opportunities that will provide background for management decisions in the future.

In regards to on-the-ground sediment and temperature control projects, the USFS, Klamath National Forest is currently working on several watershed restoration projects. The Lower Scott River Roads Analysis Process (RAP) is designed to reduce impacts to riparian areas and stream systems within the lower Scott River watershed. Specifically, the RAP will protect and improve water quality while providing a transportation system that is safe, affordable, efficient to manage, and environmentally sound. The RAP will include road storm-proofing, road maintenance, road upgrades, road decommissioning, and the creation of new roads. The Klamath National Forest is also working on a Fish Passage Project that will modify road stream crossings to allow for fish passage.

Additionally, the USFS has been a participant in the SRWC and the French Creek WAG, and has cooperated on many of the restoration and enhancement projects undertaken by those groups.

1.4.10 Klamath River Basin Fisheries Task Force

The Klamath Act (Public Law 99-552) provides for a sixteen member Klamath River Basin Fisheries Task Force, which was organized and chartered as a federal advisory committee in 1987. The Task Force includes members that "are appointed by and represent the Governors of California and Oregon; the U.S. Secretaries of Interior, Commerce and Agriculture; the California counties of Del Norte, Humboldt, Siskiyou and Trinity; Klamath County, Oregon; the Hoopa Valley, Karuk, Yurok and Klamath native tribal fishers; anglers and commercial fisherman" (Kier Associates, 1999, p. 5).

The Task Force has worked toward restoring Klamath River fisheries, primarily salmon and steelhead, by "funding watershed restoration planning and education, fisheries research and monitoring, fish stock enhancement, and on-the-ground habitat restoration" (USFWS, 2005). Between 1987 and 1998, the Task Force has helped to remediate problems related to agricultural activities in the Scott River watershed with cattle exclusion fences, riparian re-vegetation, bank stabilization, and innovative stock water systems (Kier Associates, 1999, Appendix 5).

1.5 SCOTT RIVER WATERSHED CHARACTERISTICS

1.5.1 Area and Location

The Scott River drains a 520,184-acre (813 mi^2) watershed in the Klamath Mountains in Siskiyou County in northern California, flowing generally northward into the Klamath River (Figure 1.1). The watershed shares divides with the Shasta River to the east, the Trinity River to the south, and the Salmon River to the west.

1.5.2 Population

The total resident population in the Scott River watershed in the 2000 census was estimated at approximately 8,000 (SRWC, 2004). Four "post office towns" lie in the watershed: from north to south, these towns are Fort Jones (pop. 670), Greenview (pop. 175), Etna (pop. 790), and Callahan (pop. 200) (SRWC, 2004; NationMaster.com, 2005).

1.5.3 Climate and Hydrology

The Scott River watershed has the typical hot, dry summers and cool, wet winters characteristic of Mediterranean climates. However, because the latitude of the area (between 41° N and 42° N) is at the northern extreme of the Mediterranean climate zone, and the watershed lies in a mountainous region, the watershed has colder winters than the average Mediterranean region. The Scott River watershed mainly falls within the Mediterranean highland climate region with much of the winter precipitation falling as snow.

The Scott River hydrology depends largely on precipitation stored as snow at higher elevations in the mountains to the west and south of Scott Valley, where annual precipitation is in the 60-80 inch range. Streams leaving the mountains emerge into the valley and recharge the high capacity aquifer of sand and gravel that underlies the valley. Many of the streams entering the valley from the west form alluvial fans where they enter the valley. These alluvial fans are areas where groundwater recharge occurs, and the streams often go completely dry as water percolates into the permeable gravels and cobbles.

The Scott Valley aquifer is analogous to a container that stores water. Each year the container fills during the wet periods and empties during the dry period. The amount of water passing back and forth between the stream and the aquifer is proportional to the difference in elevation of the stream water surface and the water table, and limited by the permeability of the sediments the water must pass through.

During the winter and spring the aquifer is recharged by the river and percolated precipitation (Figure 1.2 A). Once the flow has subsided, the river changes to a gaining stream (Figure 1.2 B) as stored groundwater re-enters the stream channel. In drier years, winter and spring flows are not sufficient to fully recharge the Scott Valley aquifer, the water table falls below the elevation of the river bottom (Figure 1.2 C), and the river runs dry.

In the mountains of the east side of the watershed precipitation is 12-15 inches. The eastern area is much drier because it lies in the rain shadow of the mountains to the south and west. Many of the eastside streams are ephemeral for most of their length, flowing only during precipitation events. However, the headwater reaches of many of the streams flow perennially.

Figure 1.2. Conceptual illustrations of the interaction of ground water and surface water. (From Winter et al., 1998.)

The annual precipitation recorded at Fort Jones from 1935 to 2004 is presented in Figure 1.3. Average temperatures in the valley bottom range from 33^{o}F in winter to 70^{o}F in summer. Recorded temperature extremes range from a high of 110^{o}F to a low of –23^{o}F.

The hydrologic conditions of the Scott River watershed vary widely from year to year, as indicated in Figure 1.3. The watershed experiences both floods and droughts regularly. The largest floods occur when relatively warm storm systems melt a pre-existing snow pack. The Scott River watershed is susceptible to these rain-on-snow events due to the topographic characteristics of the basin. A significant portion of the basin is between 4,500 and 5,500 feet in elevation, which is the range of elevation most susceptible to rain-on-snow. The largest floods of record (1861, 1955, 1964, 1974, and 1997) were associated with rain-on-snow events (USFS, 2000b). Drought years have occurred in 1944, 1955, 1977, 1990, 1991, 1992, 1994, 2001, and 2002. The record of annual peak flows of the Scott River near Fort Jones is presented in Figure 1.4. The record of annual minimum flows of the Scott River near Fort Jones is presented in Figure 1.5.

Despite the year-to-year variability of the Scott River hydrology, the river exhibits trends that are consistent in all but the most extreme water years. The U.S. Forest Service summarized these trends as follows:

> "Water discharge levels typically rise in November to late December in response to fall rains; peak discharge in January and February in response to large winter storms; a slight decrease in late March or early April as storms decrease and temperatures remain low; an increase in April to June from snowmelt; and a rapid decrease in discharge in June to August as snowmelt diminishes and storms have ceased. It is also evident that in every year, regardless of whether the winter was wet or dry, summer flow levels decrease to very low in August to September. This is in response to a combination of natural and man-made situations: hot days with no precipitation and intensive use of water for agriculture in Scott Valley" (USFS, 2000b).

California Department of Water Resources estimated the consumptive water use in Scott Valley as 59,400 and 65,600 acre-feet in 1998 and 2000, respectively (B. Bennett, personal communication, in Fitzgerald, 2005c). Since 1942, the average flow of the Scott River from April through September is 32, 096 acre-feet, with a total of 192,575 acre-feet passing out of the valley during the same time period, on average (USGS, data retrieved 9/6/2005).

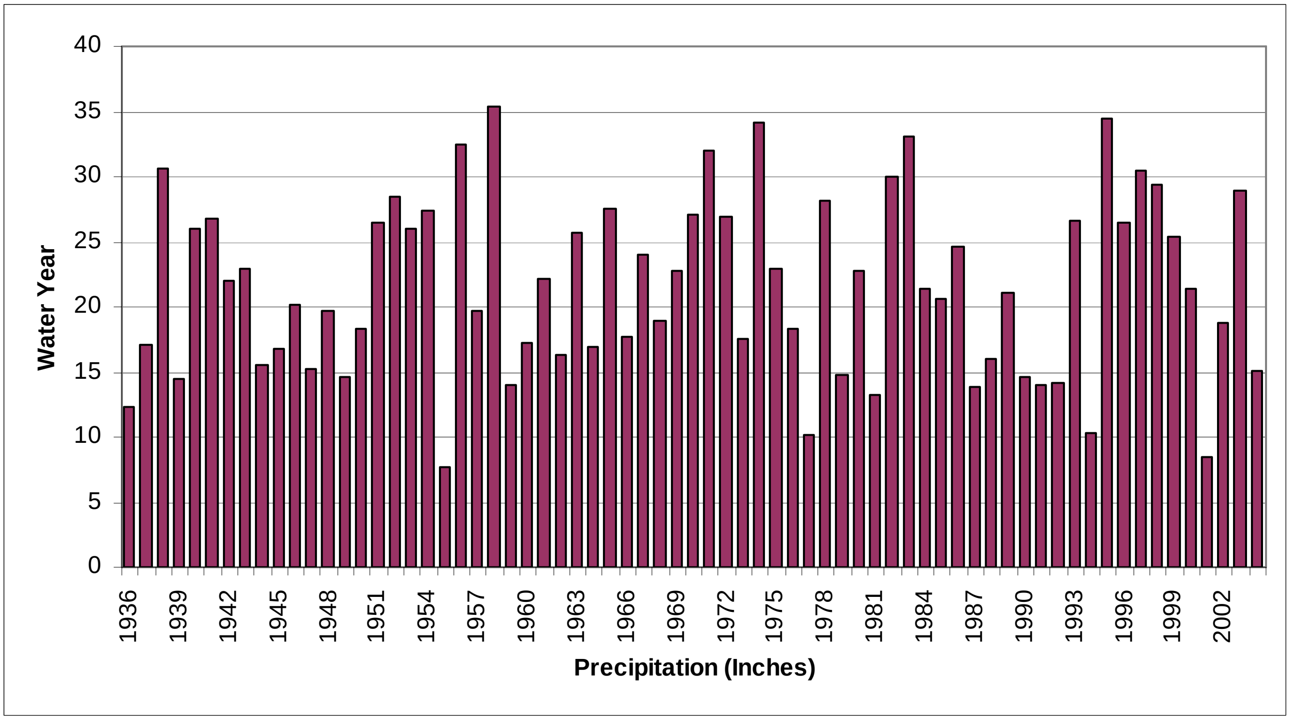

Figure 1.3: Annual precipitation measured at Fort Jones.

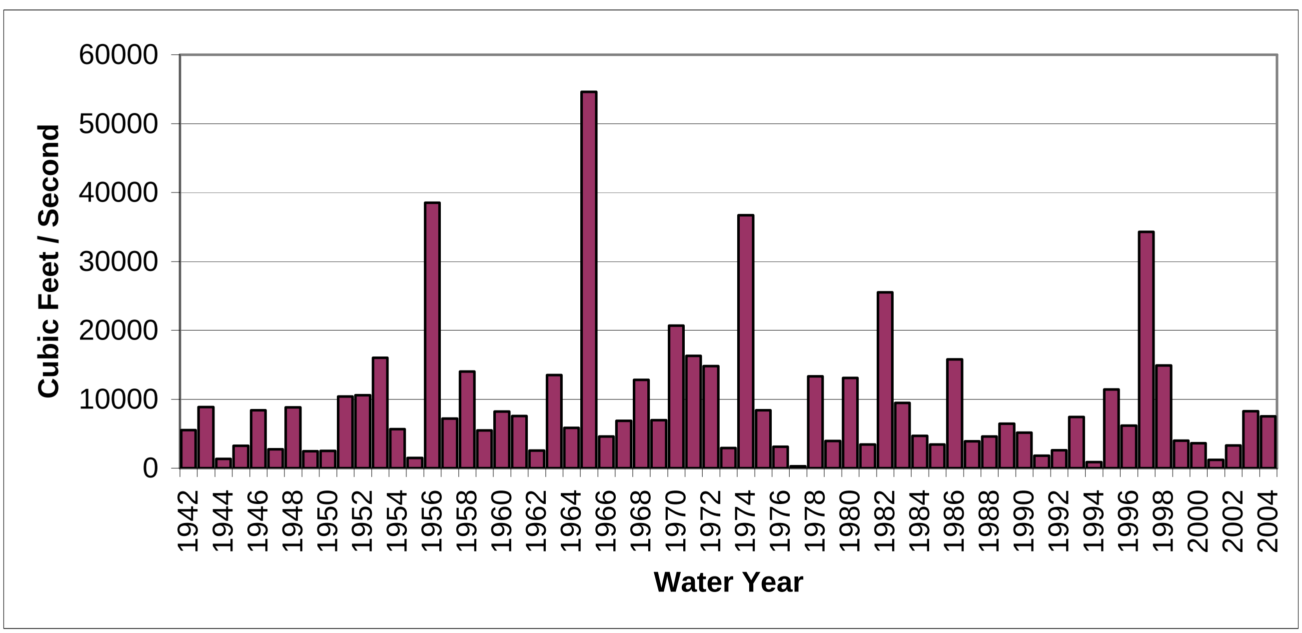

Figure 1.4: Peak flows by water year, Scott River near Fort Jones 1942-2004

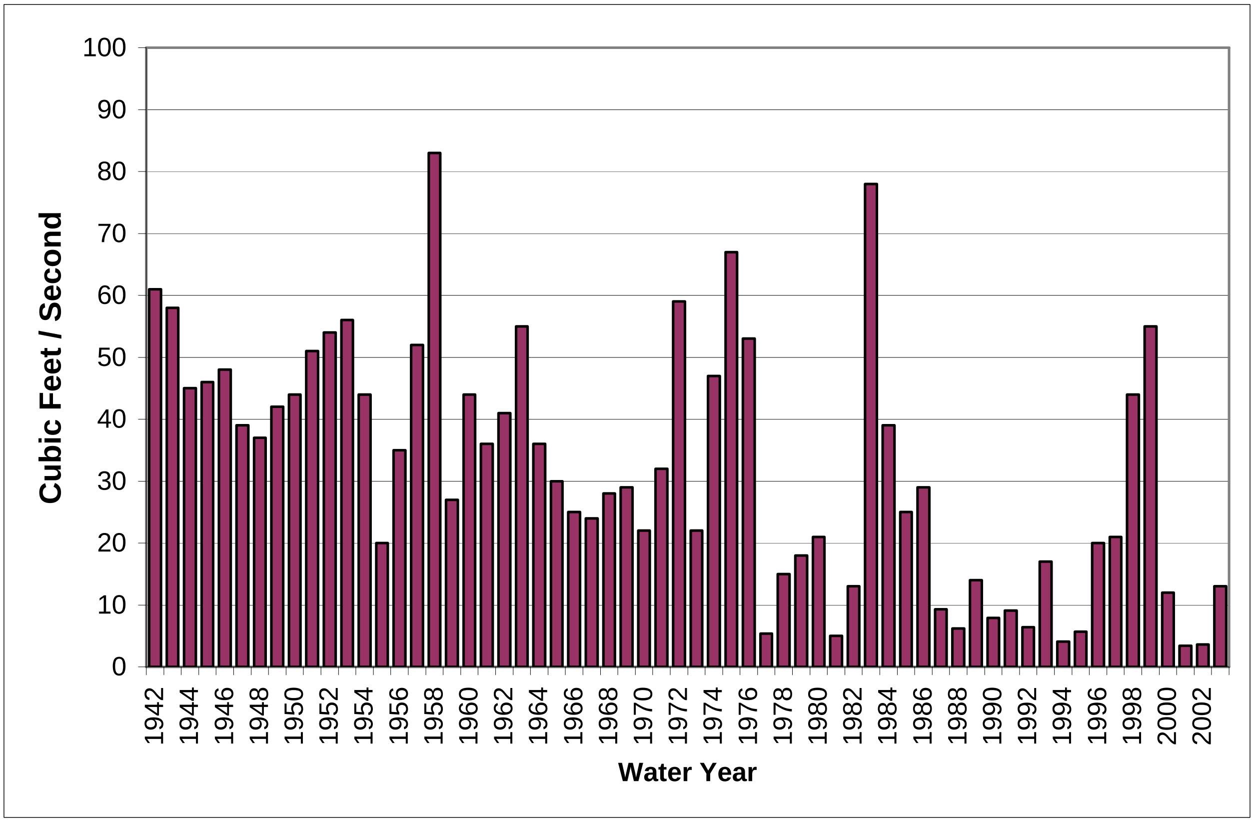

Figure 1.5: Minimum flows by water year, Scott River near Fort Jones 1942-2004

1.5.4 Topography

The watershed consists of two major types of topography. The gently graded floor of Scott Valley, about 75 mi^2, is traversed by some thirty miles of the mainstem Scott River and the lower reaches of tributaries. Surrounding this valley are steep mountains incised by steep-sided valleys carrying rushing streams. Elevations range from above 8,542 feet at China Mountain in the Scott Mountains on the southern boundary of the watershed down to the 2,500-3,200 foot range in the floor of Scott Valley. In the canyon section, downstream of Scott Valley, the Scott River descends to 1,600 feet in elevation where it enters the Klamath River.

The valley of the mainstem Scott River can be divided into two major reaches. The lower Scott River, from River Mile (RM) 0 to RM 21, known as the "canyon section," flows mostly on bedrock and is confined in a steep-sided, rocky canyon at a gradient in the range of 45-55 ft/mi. From RM 21 to about RM 50 – through flat, open, agricultural Scott Valley – is the "valley section" of the river, which flows across the gentle plain of the floor of Scott Valley. Through this section, the gradient is in the range of 4-8 ft/mi.

Table 1.1
Relative Extent of Vegetation Types in the Scott River Watershed
(Data from CalVeg online)

Vegetation Type	Percent of the Watershed
Conifer Tree Species	58%
Mixed Conifer and Hardwood Species	15%
Hardwood Species	9%
Agricultural Crops and Grassland	11%
Brush	5%
Other	2%

1.5.5 Vegetation

The vegetation of the Scott River watershed is heterogeneous and is reflective of the climatic variation that occurs in the watershed. Conifer tree species are the most common vegetation in the watershed (Table 1.1), dominating the mountains of the north, west and southern areas of the watershed. The southwestern area of the watershed is known to have the greatest diversity of conifer species in the world. The eastern areas of the watershed reflect the drier climate, with most conifers primarily found on north-facing slopes. However, western Junipers are found scattered throughout the eastern areas of the watershed.

Hardwood tree species, such as oak and madrone, compose a small portion of the vegetation of the watershed and are most common in the northern and eastern areas of the watershed. Grassland and agricultural crops compose just over ten percent of the watershed, and are primarily found in Scott Valley and areas in the East Fork Scott River watershed.

1.5.6 Geology

The Scott River watershed lies in the Klamath Mountains geologic/geomorphic province and is underlain by complex, highly deformed rocks. The bedrock is greatly varied and includes high and medium grade metamorphic rocks, slightly metamorphosed sedimentary rocks and volcanics, granite and diorite, mafic and ultramafic rocks that are largely altered to serpentine, and small amounts of limestone. This complex has been deformed by folding, intense shearing, and thrust faulting. Deformation in the last 1-2 million years has resulted in uplift in the mountains and subsidence of Scott Valley.

Scott Valley has been down-dropped and broken by faulting during late Tertiary and Quaternary time. In consequence, bedrock under the middle part of the valley is several hundred feet below bedrock near the downstream end of the valley. This great depression has been filled by sediments, mostly gravel and sand, that have been washed in and deposited by streams during the subsidence. This basin-fill deposit is a high capacity aquifer that carries the large amount of ground water that allows the abundant irrigation that supports much of the agriculture in Scott Valley.

Rich gold deposits, mostly originating in the mafic and ultramafic rocks and concentrated in stream gravels, were discovered in 1850. Intensive mining of stream and terrace gravels has led to major changes along riparian corridors.

For the purpose of this study two aspects of the geology are salient. First, geologic activity: Recent high rates of uplift have produced steep mountains that shed abundant sediment. Second, composition and structure: The rock units are so numerous and so varied in their characteristics that it is not possible in this study to consider individually all the geologic units that have been identified and mapped. For that reason, we lump the mapped geologic units into a small number of composite units that have similar characteristics relating to sediment contribution. The combining of geologic units is discussed in Section 3.1.

1.5.7 History and Land Use

Information on history and land use is synthesized from the following sources: USDA Forest Service (1997), Scott Valley Chamber of Commerce (2005), and Scott River Watershed CRMP Committee (1995) and SWRC (2004).

The Scott River watershed's longest standing residents are native Americans. The Quartz Valley Indian Community, federally recognized in 1983, includes members of the Shasta, Karuk, and Upper Klamath tribes. Tribal trust lands include the Quartz Valley Indian Reservation.

The hydrology and surface conditions in the Scott River watershed have been affected over time by several intense human activities. From about 1820 into the 1850s, systematic trapping removed a large population of beavers in the watershed. Beaver ponds provided lag time in runoff and sources of infiltration to recharge groundwater.

Rich placer gold deposits beneath the streams and floodplains, and in the gravels of river terraces, led to extensive placer mining beginning in 1850. Riparian areas along the mainstem Scott River, the South Fork, the East Fork, Oro Fino Creek, and many tributaries to the west and south of Scott Valley were greatly disturbed by placer mining. Large areas adjacent to streams were stripped of vegetation and the stream deposits hydraulically or mechanically worked to retrieve gold. These techniques left behind un-vegetated, worked river and terrace deposits, many of which persist today as piles of boulders and cobbles that still lack soil and harbor little vegetation. This type of mining ended about 1950 (USFS, 1997). Water from virtually all tributaries was diverted for use in mining. Much of the resulting ditch system has remained in use, and parts have been expanded as agriculture developed.

Agricultural activities have cleared land and created a large demand for diverted stream water and shallow ground water. Once-dense riparian vegetation has been radically reduced, except in scattered areas with riparian fencing. By the early 20th century, most of the floor of Scott Valley, and tributary valleys that were not too steep, had been cleared and converted to agriculture. There are approximately fifty square miles of irrigated land in the watershed. The quarternary areas consist of approximately eighty square miles, most of which is located within the Scott Valley. To protect farmland from bank erosion and reduce flooding, the mainstem Scott River has been straightened, rip-rap placed through much of the valley, and further constrained by levees along some stretches.

Timber harvest began along with mining, but large-scale timber harvest for export from the area has been ongoing since 1950. The extensive network of roads, skid trails, and landings, along with other associated timber harvest activities, have led to increases in sediment contributions to the stream system. Large areas underlain by decomposed granite soil ("DG" on surficial geologic maps and in local parlance) are particularly prone to chronic raveling when disturbed, and produce large amounts of sand-sized sediment.

Current land-use activities in the watershed include timber harvest on both private and public lands, irrigated agriculture (primarily alfalfa, pasture, and grain), and livestock grazing. Irrigated agricultural lands comprise about 32,000 acres, or 6%, of the watershed area. One or more of these activities have the potential to affect water quality through increased sediment loads to streams, increased solar radiation reaching streams from loss of near-stream shade, water use, and loss of large woody debris in streams.

At present, 10.4% of the Scott River watershed is protected as designated Wilderness, and 1% as Wild and Scenic River.

1.5.8 Land Ownership

Ownership of land in the Scott River watershed is summarized in Figure 1.6.

1.6 ENDANGERED SPECIES ACT CONSULTATION

The USEPA and the Regional Water Board have initiated an informal consultation process with the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration, Fisheries (NOAA Fisheries) on Klamath River TMDLs. Regional Water Board and USEPA staff have used this process to provide information and updates on the TMDLs in the Klamath basin, namely the Salmon, Scott, Shasta, Lower Lost, and Klamath River TMDLs. In addition, both NOAA Fisheries and the USFWS have attended the Scott River TMDL Technical Advisory Group meetings.

CHAPTER 2. PROBLEM STATEMENT

Key Points

- Salmonid populations in the Scott River watershed have declined significantly from historic levels. Coho salmon in the watershed are listed as a threatened species under the federal and state Endangered Species Acts.

- Excessive sediment loads and elevated water temperatures have impaired many designated beneficial uses of the Scott River and its tributaries. Several of the primary beneficial uses impaired are those uses associated with the cold water salmonid fishery, which are the primary focus of this TMDL Action Plan.

- Excessive sediment loads and elevated water temperatures have caused the non-attainment of water quality objectives related to sediment and water temperature.

- Excessive sediment:
  - fills in pools, reducing available in-stream salmonid habitat;
  - fills and buries the gravels that salmonids require to spawn;
  - reduces the number of macroinvertebrates available as food for salmonids during rearing;
  - produces wider, shallower channels which are subject to increased solar heating and contribute to the non-attainment of the temperature objective.

- Available data on instream sediment conditions in the mainstem Scott River through Scott Valley show a consistent pattern of sediment impairment, though with indications of improving trends for some parameters.

- Available data on instream sediment conditions in Shackleford-Mill, Etna, French, and Sugar creeks show mixed conditions, with some parameters exceeding desired conditions, some meeting desired conditions, and some with stable or improving trends in fine sediment values.

- Available data on instream sediment conditions in Tompkins, Boulder, and Canyon creeks generally indicate sediment impairment.

- The recommended salmonid temperature criteria during the summer ranges from 16ºC (60.8ºF) to 20ºC (68ºF) 7-DADM, depending on salmonid life stage.

- Summer temperature conditions do not support suitable salmonid rearing habitat in the mainstem of the Scott River and the East Fork of the Scott River.

- Summer temperature conditions do not support suitable salmonid rearing habitat in the lower reaches of Kelsey, Shackleford, Kidder, Patterson (west side), French, Wildcat, Etna, and Big Carmen creeks and the upper reaches of Moffet Creek and Sissel Gulch.

- A suite of instream salmonid habitat and upslope watershed desired conditions is available to help determine water quality and the effectiveness of the TMDL and implementation actions.

- This chapter also includes information on salmonid populations and periodicity in the Scott River watershed.

2.1 INTRODUCTION

This chapter summarizes ways in which increased sediment loads and elevated water temperatures have contributed to the decline of the cold-water salmonid fishery. Increased sediment delivery is produced by management activities including road-related activities, silvicultural and agricultural practices, mining, and ranching. Temperature changes are produced by sediment delivery – through processes including channel aggradation and pool infilling – as well as by other processes, such as changes in riparian cover, increased solar heating, changes in surface flow, changes in channel geometry, and changes in streamside microclimates. This chapter includes a description of the water quality standards and salmonid habitat requirements related to sediment and temperature and a qualitative assessment of existing instream and watershed conditions in the Scott River watershed.

The primary adverse impacts produced by excessive sediment supply in the Scott River and its tributaries are adverse effects on the cold-water salmonid fishery. Excessive sediment fills pools, reducing available habitat. Fine sediment, which constitutes most of the additional sediment load, fills and buries the gravels that salmonids require to spawn. In addition, the influx of fine sediments reduces the number of macroinvertebrates available for food during salmonid rearing. Excess sediment produces wider, shallower channels which are subject to solar heating and contribute to the non-attainment of temperature objectives. Increased water temperatures decrease the area and volume of suitable habitat, and decrease salmonid survival during gestation, rearing, and migration.

The degradation of sediment and temperature conditions below water quality objectives adversely affects beneficial uses related to coho salmon (*Oncorhynchus kisutch*), chinook salmon (*O. tshawytscha*), and steelhead trout (*O. mykiss*). The coho salmon population in this watershed is listed as threatened under the federal Endangered Species Act and the California Endangered Species Act. Additional adverse impacts affect recreational uses, agricultural and municipal water supplies, and ground water recharge.

This analysis is based on data that have been gathered by the Regional Water Board staff and data contributed by landowners and organizations in the Scott River watershed. Because information about habitat parameters in some areas of the watershed is not available, conservative assumptions based on professional judgment were made regarding factors that potentially limit salmonid populations in the basin. As additional data become available from sources such as local groups and government agencies, the TMDL and information contained in this chapter can be modified by the Regional Water Board.

2.2 WATER QUALITY STANDARDS

In accordance with the Clean Water Act, a TMDL is set at a level necessary to achieve applicable water quality standards. Under the Clean Water Act, water quality standards define designated uses, water quality criteria to protect those uses, and an anti-degradation policy. This section describes the State water quality standards applicable to the Scott River TMDL, using the State's terminology of beneficial uses and water quality objectives. The Scott River TMDLs for sediment and temperature are set at levels necessary to protect applicable water quality standards, including the beneficial uses listed in Section 2.2.1 and the water quality objectives listed in Section 2.2.2.

2.2.1 Beneficial Uses

The beneficial uses and water quality objectives for the Scott River are contained in the *Water Quality Control Plan for the North Coast Region* (Basin Plan) adopted, 1993, as amended in 2003 (Regional Water Board, 2003, Table 2-1). Beneficial uses are defined on the basis of two hydrologic subareas: the Scott Bar Hydrologic Subarea and the Scott Valley Hydrologic Subarea.

Existing beneficial uses for the Scott River are:
1. Municipal Water Supply (MUN)
2. Agricultural Supply (AGR)
3. Industrial Service Supply (IND)
4. Groundwater Recharge (GWR)
5. Freshwater Replenishment (FRSH)
6. Navigation (NAV)
7. Hydropower Generation (POW)
8. Water Contact Recreation (REC-1)
9. Non-Contact Water Recreation (REC-2)
10. Commercial or Sport Fishing (COMM)
11. Cold Freshwater Habitat (COLD)
12. Wildlife Habitat (WILD)
13. Rare Threatened or Endangered Species (RARE)
14. Migration of Aquatic Organisms (MIGR)
15. Spawning, Reproduction, and/or Early Development (SPWN)
16. Aquaculture (AQUA) (Scott Valley Hydrologic Subarea)

Potential beneficial uses are:
1. Industrial Process Supply (PRO)
2. Aquaculture (AQUA) (Scott Bar Hydrologic Subarea)

Table 2.1 Water Quality Objectives Applicable to the Scott River TMDL	
Suspended Material	Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.
Settleable Material	Waters shall not contain substances in concentrations that result in deposition of material that causes nuisance or adversely affect beneficial uses.
Turbidity	Turbidity shall not be increased more than 20 percent above naturally occurring background levels. Allowable zones of dilution within which higher percentages can be tolerated may be defined for specific discharges upon the issuance of discharge permits or waiver thereof.
Sediment	The suspended sediment load and suspended sediment discharge rate of surface water shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.
Temperature	The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses. At no time or place shall the temperature of any COLD water be increased by more than 5° F above natural receiving water temperature.

2.2.2 Water Quality Objectives

The Basin Plan (NCRWQCB, 2005b) identifies both numeric and narrative water quality objectives for the Scott River. Those pertinent to the Scott River TMDLs are listed in Table 2.1.

2.3 SALMONID POPULATIONS & PERIODICITY

Many of the beneficial uses most impaired by and sensitive to excessive sediment loads and elevated water temperatures are related to the cold water salmonid fishery. These uses include the commercial and sport fishing (COMM); cold freshwater habitat (COLD); rare, threatened, and endangered species (RARE); migration of aquatic organisms (MIGR); and spawning, reproduction, and/or early development of fish (SPWN) beneficial uses. The following sections provide some background information on the status of salmonid populations, the locations of salmonid habitat, and salmonid periodicity within the Scott River watershed.

2.3.1 Salmonid Populations

Anadromous fish populations currently utilizing the Scott River basin include fall chinook and coho salmon, and fall and winter steelhead trout (Hardy and Addley, 2001, p.12; Klamath River Basin Fisheries Task Force [KRBFTF], 1991, p. 4-10 and 4-11). Data indicate that the fall chinook population within the Scott River basin has experienced a decline since at least the

1960s (Hardy and Addley, 2001, p.12). Available data for coho and fall and winter steelhead runs are not entirely reliable for determining long-term trends, however both species are considered to have experienced declines from historic numbers throughout the Klamath River basin (Brown and Moyle, 1991, p.6, 36; Brown et al., 1994; CDFG, 2002, p.1; Hardy and Addley, 2001, p.12-13). Historically, there were summer steelhead and spring chinook runs in the Scott River, however those runs no longer occur in this basin although a few random summer steelhead have been observed in the Scott River (KRBFTF, 1991. p. 2-87, 2-99, and 4-15; USFS, 2000b, p.3-9; USFS, 2000a). This review focuses on adult return populations.

Information on the numbers of coho salmon and steelhead trout in the Scott River basin is limited. In the early 1960s, the California Department of Water Resources (CDWR) estimated 2,000 coho and 20,000-40,000 steelhead in the Scott River basin (CDWR 1965, as cited by Scott River Watershed Council [SRWC], 2004, p.6-5). An inventory of salmon and steelhead conducted by the California Department of Fish and Game (1965, p.373) estimated 800 coho, and 5,000 steelhead in the basin in 1965. There are data on juvenile coho numbers in the French Creek drainage, discussed below. No other population estimates could be found for coho and steelhead in this basin. Information on coho and steelhead numbers were found for various years from 1982-1991 (Shaw et al., 1997) however, no population estimates were made from this information. In addition, adult spawner population estimates were developed for selected reaches in French, Miners, Shackleford, and Mill Creeks by the Siskiyou County Resource Conservation District in 2004-2005. Depending on the method used to calculate estimates, adult coho population estimates in these select reaches total 713 or 940 adult fish (SRCD, 2005c, p.5). Due to the lack of spawner abundance estimates in other recent years, it is not possible to use these results to indicate trends in reaches of these creeks or in the watershed as a whole.

In the absence of quantitative data it is assumed that the trends in coho salmon and steelhead trout within the Scott River basin are similar to trends within the larger Klamath Basin (Hardy and Addley, 2001, p.12). Despite this lack of quantitative data, it is clear from the information available that coho and steelhead populations within the Klamath basin and statewide have undergone a dramatic decline from historic levels (Brown and Moyle, 1991, p.6 and 36; Brown et al, 1994; CDFG, 2002, p.1; Hardy and Addley, 2001, p.12 and 13). The National Marine Fisheries Service (NMFS) listed the Southern Oregon/Northern California Coastal (SONCC) Coho Salmon Evolutionarily Significant Unit (ESU), which contains the Scott River basin, as threatened in 1997 (NMFS, 2004). The California Department of Fish and Game (CDFG) commission proposed the listing of this ESU as threatened in August of 2004, and this proposal will become effective upon approval by the Office of Administrative Law (CDFG, 2004b). Brown et al. (1994) state that California coho populations are probably less than 6% of what they were in the 1940s, and there has been at least a 70% decline since the 1960s. Coho salmon occupy only 61% of the SONCC Coho ESU streams that were previously identified as historical coho salmon streams (CDFG, 2002, p.2).

Historically, sustainable populations of spring chinook were present in the Scott River watershed but these stocks are either no longer present or occur very infrequently in low numbers (USFS, 2000b, p. 3-9). There have been occasional sightings of spring chinook in the Scott River, although the only true run in the Klamath basin exists in the Salmon River (KRBFTF, 1991, p 4-12). Snyder (1931, p. 19) wrote that the spring chinook migration in the Klamath basin, “was once very pronounced," but "has now come to be limited as to the number of individuals, and is of relatively little economic importance." The cause of the disappearance or depletion of the early spring migration in the Klamath River is attributed by some to heavy sediment loads unleashed by hydraulic mining operations (KRBFTF, 1991, 4-2), while others cite over fishing both in the river and at sea, and irrigation (Snyder, 1931, p.33).

Fall chinook salmon are the predominant run in the Klamath River basin and are the only chinook run believed to currently exist in the Scott River basin. The Scott River produces approximately 9.2% of the natural fall Chinook salmon in the Klamath River basin (SRWC, 2004, p.6-1). An historic population estimate from CDFG (1965, p. 373) estimated that there were 8,000 fall chinook in the Scott River basin in 1965. Fall chinook salmon spawning escapement has been monitored by the CDFG annually since 1978 (Figure 2.1). Since this time, spawning populations have ranged from 445 fish in 2004, to a high of 14,477 fish in 1995. Fall chinook numbers remained high in 1996 (12,097) and then decreased to between 3,327-6,253 from 1997-2002, but rebounded again in 2003 to 12,053 fish.

Juvenile coho salmon surveys have been conducted in French Creek in most years from 1992 to the present, in conjunction with an intensive road rehabilitation effort conducted in this drainage in the early 1990s. Effects of this effort on V*, a measure of instream sediment conditions, are discussed in Section 2.4.2.7. Juvenile coho salmon have been found regularly in several French Creek reaches as part of annual September electroshock monitoring initiated in 1992 and overseen by Department of Fish and Game fisheries biologist Dennis Maria. These surveys have been conducted each year since 1992 except for 1998. Since 1992 the surveys have been done in the same five reaches, except for 1996 when one reach was not surveyed. These survey data (Figure 2.2) provide the single best data set on coho salmon in the Scott River system.

Coho return as adults three years after they are spawned. Thus a fry hatched from the 1999 spawn, if it survived, returned as a spawning adult in 2002. We designate 1992, 1993, and 1994 as Brood Years 1, 2, and 3. When each brood year is looked at separately trends are apparent:

- Brood Year 2 (1993, 1996, 1999, 2002) is by far the strongest of the three with data through 2002.
- Brood Years 1 and 3 are much weaker than Brood Year 2
- All Brood Years show positive trends with Brood Years 1 and 3 now showing numbers and trends similar to those shown by Brood Year 2 approximately ten years ago.
- Given that Brood Years 1 and 3 were the best ever documented in 2004 and 2005, it can be reasonably anticipated that the juvenile survey taken in September of 2005 will also be strong.

2.3.2 Salmonid Habitat

A habitat survey performed by the CDFG (1965, p. 373) found that there were 59 miles of habitat in the Scott River basin suitable for chinook, 126 miles suitable for coho, and 174 miles of habitat suitable for steelhead in 1965. A more current survey by Hardy and Addley (2001, p.13) estimates that there are 59 miles of fall chinook, 88 miles of coho, and 142 miles of steelhead habitat in the basin. Stream diversions have reduced the amount of available salmon and steelhead habitat in the Scott River basin, and may have been the primary cause for the loss of the summer steelhead and spring chinook runs in this basin (KRBFTF, 1991, 2-99).

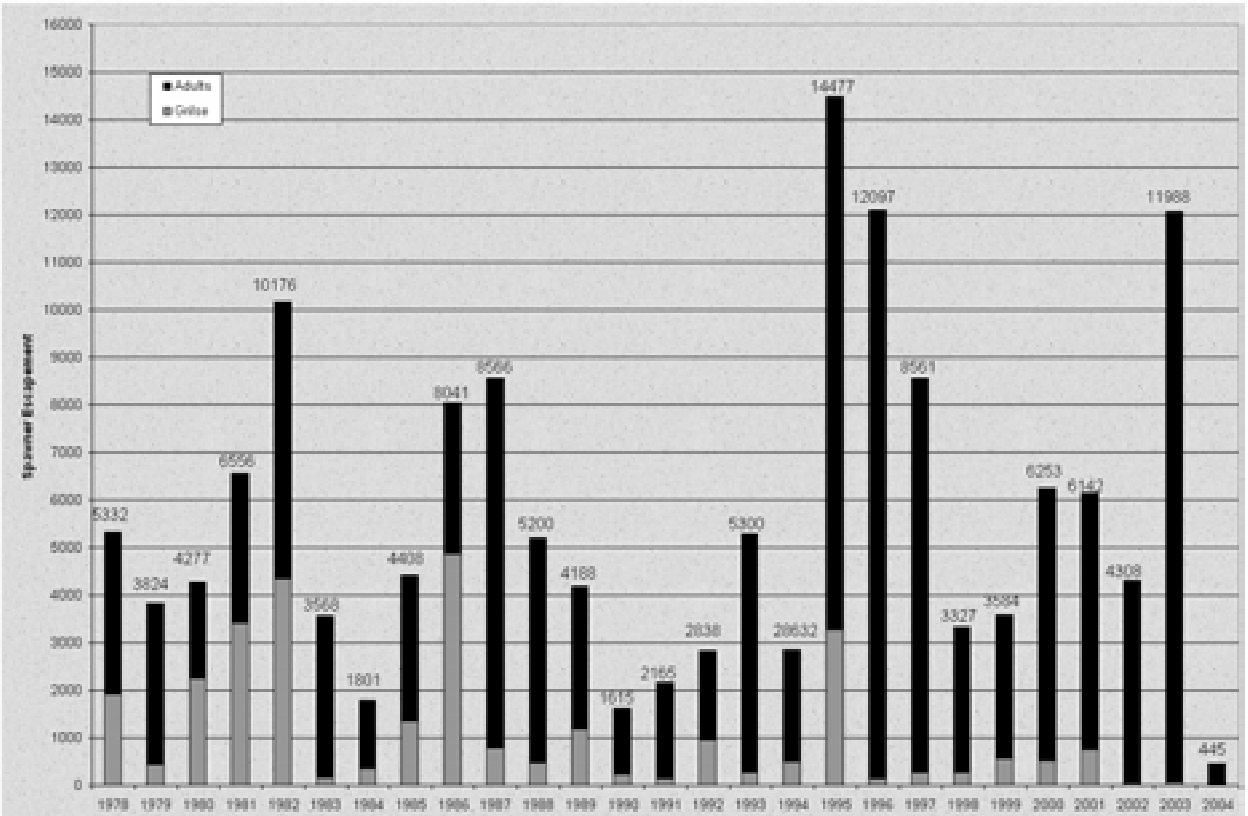

Figure 2.1. Scott River Fall Chinook Spawner Escapement (Source: CDFG data)

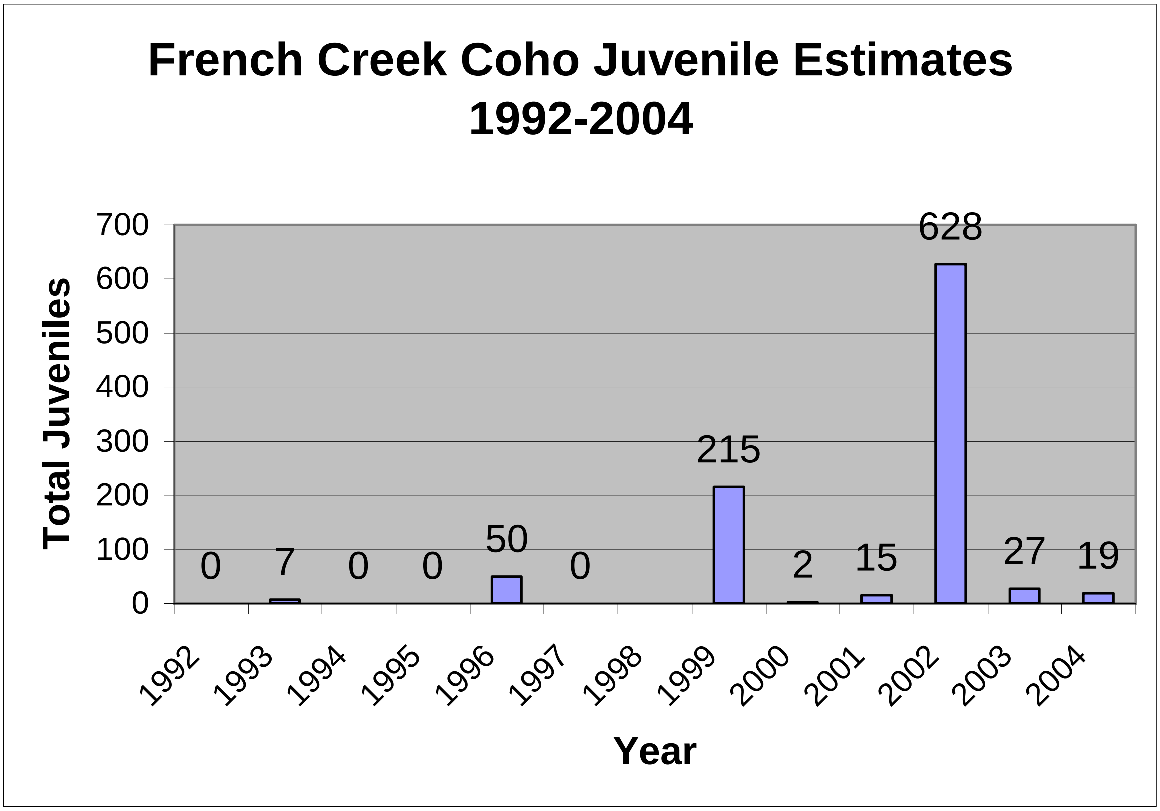

Figure 2.2. Juvenile coho estimates from electroshocking surveys on five reaches of French Creek from 1992-2004.

2.3.3 Salmonid Periodicity

Six runs of anadromous salmonids use the Klamath River, four of which are found in the Scott River basin. Fall run chinook, coho, and fall and winter run steelhead all are found in the Scott River basin, while spring chinook and summer steelhead runs are not currently present except for a few random summer steelhead. Together these four runs result in year round utilization of the Scott River basin by various life stages of salmonids (Figure 2.2).

Periodicity (presence of salmonids at varying life stages throughout the year) information for the runs is fairly easy to interpret with the exception of data for the fall and winter run steelhead. At times references do not distinguish between fall and winter steelhead, some calling all fish winter run steelhead (see for example Leidy and Leidy, 1984), while others only refer to fall fish (see for example Hardy and Addley 2001, p.12). In other references the discussion of fall and winter run steelhead is combined (see for example KRBFTF, 1991, p. 4-11; SRWC, 2004, p.6-18). Finally, some documents discuss the fall and winter steelhead separately (Shaw et al., 1997). For this reason, periodicity information for fall and winter steelhead in this document are combined into one group. Information from the above literature sources, Chesney (2000, p. 1-5, 19-27, and 33-37, 2002, p. 23-38, 2003. p. 21-39, 2004, p. 21-37), and the SRWC (2004, p. 6-3, 6-4, 6-17, and 6-18) were used to produce Figure 2.3.

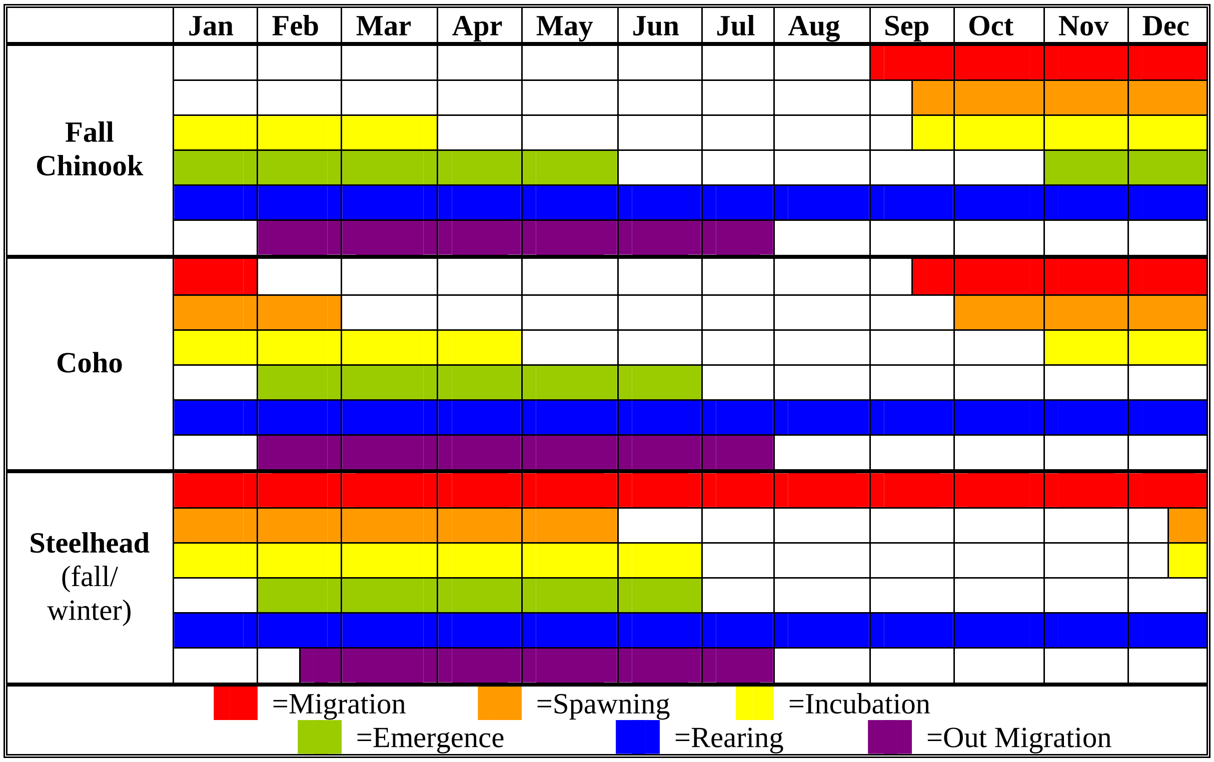

Figure 2.3. Salmonid Periodicity in the Scott River Watershed.

2.4 SEDIMENT PROBLEM STATEMENT

The primary adverse impacts produced by excessive sediment supply in the Scott River and its tributaries are adverse effects on the cold-water salmonid fishery. Excessive sediment fills pools, reducing available habitat. Fine sediment, which constitutes most of the additional sediment load, fills and buries the gravels that salmonids require to spawn. In addition, the influx of fine sediments reduces the number of macroinvertebrates available for food during salmonid rearing. Excess sediment produces wider, shallower channels which are subject to solar heating and contribute to the non-attainment of temperature objectives.

2.4.1 Sediment Desired Conditions

This section identifies desired conditions for salmonid freshwater habitat and upslope settings. These indicators are interpretations of the water quality standards presented in two categories, instream conditions and watershed conditions.[1] For each parameter, a desired condition value is identified. These parameters, and their associated desired condition values, although not directly

[1] Turbidity is the only exception as turbidity is a water quality objective listed in the Basin Plan.

enforceable, have proved to be a useful reference in determining the effectiveness of a TMDL and implementation measures toward attaining water quality standards.[1]

The instream desired conditions relate to the quality and size distribution of sediment and are important as measures of stream health. The watershed desired conditions focus on the environment upslope of the streams and reflect either predictors of or protection against future degradation of water quality. Watershed parameters focus on imminent threats to water quality that can be detected and corrected before sediment is delivered to the stream. Watershed parameters are often easier to measure than instream parameters and identify conditions that are needed in the watershed to protect water quality as it relates to sediment conditions.

Desired conditions values of both instream and watershed parameters are set at levels associated with well-functioning stream systems. Instream parameters reflect present conditions, but these conditions may take years or decades to respond to changes higher in the watershed. Watershed parameters reflect processes upslope from the streams in the watershed at the time of measurement, and may respond relatively quickly to induced changes. The linkages relating production of sediment upslope, delivery of that sediment to a stream, and what happens to that sediment in the stream are complex. Time lags between production and delivery of sediment, instream storage, and times and processes of transport through the system are not always well known. Accordingly, watershed desired conditions potentially can be achieved sooner than instream desired conditions, and can serve as checks on the progress toward achievement of water quality standards.

No single parameter adequately describes water quality with relation to sediment; instead, a suite of instream conditions and a suite of watershed conditions are identified. Because of the inherent variability associated with stream channel conditions, and because no single indicator applies in all situations, attainment of the desired conditions is evaluated using a weight-of-evidence approach. Experience shows that the parameters, when considered together, provide good evidence of the condition of the stream and of progress toward attainment of sediment-related water quality standards.

2.4.1.1 Instream Desired Conditions for Sediment

Tables 2.2 and 2.3 list the instream salmonid habitat desired conditions for the Scott River TMDL and their respective desired condition values. In several cases, desired conditions are expressed as improving trends, because information on watershed processes is not adequate to develop thresholds specific to the Scott River watershed. These parameters and their application are discussed by Fitzgerald (2004), which also includes a discussion of the literature on these indicators, their importance in characterizing instream conditions suitable for salmonids, and desired condition values for the indicators.

2.4.1.2 Watershed Desired Conditions for Sediment

Table 2.4 lists the watershed desired conditions for the Scott River TMDL and their respective desired condition values. More information on each parameter is found in the following sections. Watershed desired conditions are indicators of potential future sediment contributions to the stream system. The information on watershed desired conditions includes reported conditions taken from several publicly funded inventories including surveys in French Creek (Sommarstrom et al., 1990), Etna Creek (Resource Management, 2003), Moffett Creek (SHN Consulting Engineers & Geologists, 2003), Shackleford and Mill creeks (Siskiyou Resource Conservation District, 2003), and others. In several cases, desired conditions are expressed as improving trends, because information on watershed processes is not adequate to develop thresholds specific to the Scott River watershed.

Stream Crossings with Diversion Potential or Significant Failure Potential

Desired Condition: <1% of all stream crossings divert or fail as a result of a 100-year or smaller flood

Most roads, including skid trails, cross ephemeral or perennial streams. Crossings are built to capture the stream flow and safely convey it through, under, or around the roadbed. However, stream crossings can fail, adding sediment from the crossing structure (i.e., fill), or from the roadbed, directly into the stream. Stream crossing failures are generally related to culverts that are undersized, poorly placed, plugged, or partially plugged. When a crossing fails, the total sediment volume delivered to the stream usually includes both the volume of road fill associated with the crossing and sediment from collateral failures such as debris torrents that scour the channel and stream banks.

Diversion potential is the potential for a road to divert water from its intended drainage system across or through the road fill, thereby delivering road-related sediment to a watercourse. The potential to deliver sediment to the stream can be eliminated from almost all stream crossings by eliminating inboard ditches, outsloping roads, or installing rolling dips (M. Furniss, pers. comm., in USEPA, 1998). Generally, less than one percent of stream crossings have conditions where modification is inappropriate because it would endanger travelers or where modification is impractical because of physical constraints (D. Hagans, pers. comm., 1998, in USEPA, 1998).

Table 2.2
Instream Desired Conditions for Sediment*

Parameter	Desired Condition	Applicability	Monitoring/Sampling Notes
Benthic Macroinvertebrate Assemblage	≥ 18 Index Score per the Russian River Index of Biological Integrity (IBI). See Table 2.3 for the Russian River IBI.	1st, 2nd, and 3rd Order Streams.	Monitoring and calculation should occur in the spring according to the protocols found in the *California Stream Bioassessment Procedure* (CA Department of Fish and Game, 2003).
Embeddedness	Increasing trend in the number of locations where gravels and cobbles are ≤ 25% embedded.	All wadeable streams and rivers.	Monitoring should occur according to the protocols found in the *California Salmonid Stream Habitat Restoration Manual, Third Edition* (Flosi et al., 2004).
Large Woody Debris (LWD)	Increasing trend in the volume and frequency of LWD and key pieces of LWD.	Streams and rivers with bankfull channel widths > 1m.	Monitoring should be done according to the protocols found in the *California Salmonid Stream Restoration Manual, Third Edition* by Flosi et al. (2004), or in the Washington State *Method Manual for the Large Woody Debris Survey* (Shuett-Hames et al., 1999).
Pools –	Increasing trend in	Wadeable streams and rivers with	Monitoring should occur periodically during

Table 2.2
Instream Desired Conditions for Sediment*

Parameter	**Desired Condition**	**Applicability**	**Monitoring/Sampling Notes**
Backwater Pool Distribution	the number of backwater pools.	channel morphology that supports the development of backwater pools. Steep, v-shaped valleys with little floodplain connection generally do not exhibit this type of habitat and are exempt from this index.	the low-flow period and after a heavy winter storm according to the protocols found in the *California Salmonid Stream Restoration Manual, Third Edition* (Flosi et al., 2004).
Pools – Lateral Scour Pool Distribution	Increasing trend in the number of lateral scour pools.	Wadeable streams and rivers with channel morphology that supports the development of backwater pools. Steep, v-shaped valleys with little floodplain connection generally do not exhibit this type of habitat and are exempt from this index.	Monitoring should occur during the low-flow period, after a heavy winter storm, once every five to ten years according to the protocols found in the *California Salmonid Stream Restoration Manual, Third Edition* (Flosi et al., 2004).
Pools – Primary Pool Distribution	Increasing trend in the number of reaches where the length of the reach is composed of ≥ 40% primary pools.	All wadeable streams and rivers.	Monitoring should occur once every five to ten years during the low-flow period and after a heavy winter storm according to the protocols found in the *California Salmonid Stream Restoration Manual, Third Edition* (Flosi et al., 2004). Reported data should include length and depth of pools, and the number of primary pools.
Percent Fines	≤ 14% fines < 0.85 mm in diameter. ≤ 30% fines < 6.40 mm in diameter.	Wadeable streams and rivers with a gradient < 3%.	Monitoring should use a McNeil sediment core sampler similar to the specifications found in *Success of Pink Salmon Spawning Relative to Size of Spawning Bed Materials* (McNeil and Ahnell, 1964), except the diameter of the sampler's core should be at least 2-3 times larger than the largest substrate particle usually encountered. Monitoring should occur according the protocols found in *Stream Substrate Quality for Salmonids: Guidelines for Sampling, Processing, and Analysis* (Valentine, 1995), and use the methodology for the redd or pool/riffle break sampling universe. A 0.85 mm a 6.40 mm sieve should be used during sample processing. The wet volumetric method is recommended with the use of the wet volumetric method and the dry gravimetric method on 10% of the samples.
Thalweg Profile	Increasing variation in the thalweg elevation around the mean thalweg profile slope.	Streams and rivers with slopes ≤ 2%.	Monitoring should occur during the low-flow period, after a heavy winter storm, once every five to ten years. The monitored stream segments should be at least 20, but usually 30 to 40, times as long as the average bankfull channel width. Points that should be surveyed include the thalweg, all breaks-in-slope, riffle crests, maximum pool depths, tails of pools, and surface water elevation. Acceptable monitoring protocols include the Channel

Table 2.2 **Instream Desired Conditions for Sediment***			
Parameter	**Desired Condition**	**Applicability**	**Monitoring/Sampling Notes**
			Geometry Survey of *Water in Environmental Planning* (Dunne and Leopold, 1978).

* Adapted from Fitzgerald, 2004.

Table 2.3 **Russian River Index of Biological Integrity**				
Biological Metric	**Score**			**How to use the Russian River Index of Biological Integrity**
	5	**3**	**1**	
Taxa Richness	> 35	35-26	< 26	Obtain a sample of benthic macroinvertebrates following the state standard procedures in *California Stream Bioassessment Procedure. Protocol Brief for Biological and Physical/Habitat Assessment in Wadeable Streams* (CA Dept. of Fish and Game, 2003). There must be at least three replicate samples collected at each monitoring location. The samples should be processed by a professional bioassessment laboratory using the Level 3 Taxonomic Effort. Determine the mean values for the six listed biological metrics, compare them to the values in the columns, and add the scores listed in the column headings. The total score will be between a low of 6 and a high of 30. Determine biotic condition of the monitoring location from the following categories: Excellent 30-24; Good 23-18; Fair 17-12; Poor 11-6
% Dominant Taxa	< 15	15-39	> 39	
EPT Taxa	> 18	18-12	< 12	
Modified EPT Index	> 53	53-17	< 17	
Shannon Diversity	> 2.9	2.9-2.3	< 2.3	
Tolerance Value	< 3.1	3.1-4.6	> 4.6	

1.Taken from *Measuring the Health of California Streams and River. A Methods Manual for: Water Resource Professionals, Citizen Monitors, and Natural Resources Students* by Harrington & Born (1999).

Table 2.4 **Watershed Desired Conditions for Sediment**				
Parameter	**Desired Condition**	**Comments**	**Purpose**	**References**
Watershed	Monitoring recommendations: prior to winter			
Diversion & Stream Crossing Failure Potential	≤ 1% of crossings divert or fail in 100 yr storm.	Measured prior to winter.	Estimate of potential for reduced risk of sediment delivery from hillslope sources to the water body.	Weaver and Hagans, 1994; Flanagan et al., 1998.
Hydrologic Connectivity of Roads	Decreasing length of connected road to ≤ 1%.	Measured prior to winter.	Estimate of potential for reduced risk of sediment delivery from hillslope	Ziemer, 1998; Flanagan et al., 1998; Furniss et al., 2000.

Table 2.4
Watershed Desired Conditions for Sediment

Parameter	Desired Condition	Comments	Purpose	References
			sources to the water body.	
Annual Road Inspection & Correction	Increasing proportion of road to 100%.	Roads inspected and maintained, decommissioned or hydrologically closed prior to winter. No migration barriers.	Estimate of potential for reduced risk of sediment delivery from hillslope sources to the water body.	USEPA, 1998.
Road Location, Surfacing, & Sidecast	Decreasing length next to stream, increased % outsloped, and hard surfaced roads	See text	Minimize sediment delivery.	USEPA, 1998.
Activities in Unstable Areas	Avoid or eliminate.	Subject to geological / geotechnical assessment to minimize or show that no increased delivery would result.	Minimize sediment delivery from management activities.	Dietrich et al., 1998; Weaver and Hagans, 1994; PWA, 1998.
Disturbed Areas	Decrease	See text.	Measure of chronic sediment input.	Lewis, 1998.

Hydrologic Connectivity

Desired Condition: decreasing length of hydrologically connected roads to ≤1%
A hydrologically connected road drains water directly to the adjacent stream, which increases the intensity, frequency, and magnitude of flood flows and suspended sediment loads in the stream. This process can destabilize the stream channel and produce a devastating effect on salmonid redds and growing embryos (Lisle, 1989). The hydrologic connectivity can be reduced by outsloping roads, creating road drainage that mimics natural drainage as much as possible, and other factors (M. Furniss, pers. comm., 1998 in USEPA, 1998; Weaver and Hagans, 1994). The reduction of road densities and the reconstruction of roads to reduce the miles of inboard ditches, for example, can reduce the amount of water that is directly delivered to watercourses, as well as associated sediment load.

Annual Road Inspection and Correction

Desired Condition: increasing proportion to 100%
U.S. EPA's analysis indicates that in watersheds with road networks that have not experienced excessive road-related sedimentation, roads are either (1) regularly inspected and maintained; (2) hydrologically maintenance free (i.e., they do not alter the natural hydrology of the stream); or (3) decommissioned or hydrologically closed (i.e., fills and culverts have been removed and the natural hydrology of the hillslope has largely been restored). Roads that do not meet one of these conditions are potentially large sources of sediment (D. Hagans, pers. comm., 1998, cited in USEPA, 1998). In general, road inspection should be done annually and could in most cases be accomplished with a windshield survey. The areas with significant potential for sediment delivery should be corrected before the onset of winter conditions. This desired condition calls for an increase in the proportion of roads that are either (1) inspected annually and maintained before winter, (2) hydrologically maintenance free, or (3) decommissioned or hydrologically closed.

Road Location, Surfacing, & Sidecast

Desired Condition: decrease road length next to streams and increase proportion of out-sloped or hard surfaced roads This indicator is intended to address the highest risk sediment delivery from roads that are not covered in other indicators. Roads in inner gorges and headwall areas are more likely to fail than roads in other topographic locations. Other than along ephemeral watercourses, roads should be removed from inner gorge and potentially unstable headwall areas, except where alternative road locations are unavailable and the road is clearly needed. Road surfacing and use intensity directly influence sediment delivery from roads. Rock surfacing or paving is appropriate for frequently used roads. Sidecast on steep slopes can trigger earth movements, potentially resulting in sediment delivery to watercourses. These factors reflect the highest risk of sediment delivery from roads, and should be the highest priorities for correction (Flanagan et al., 1998).

This desired condition calls for several conditions: (1) elimination of roads alongside inner gorge stream reaches and in potentially unstable headwall areas, unless alternative road locations are unavailable and the road is clearly needed, (2) road surfacing, drainage methods, and maintenance should be appropriate to the road's use patterns and intensities, and (3) sidecast or fill on slopes of greater than 50 percent grade, and potentially unstable slopes that could deliver sediment to a watercourse, should be stabilized or re-graded to fifty percent grade or less.

Activity in Unstable Areas

Desired Condition: avoid or eliminate, unless detailed geologic assessment by a Certified Engineering Geologist concludes there is no additional potential for increased sediment loading
Unstable areas are those areas that have a high risk of landsliding, and include steep slopes, inner gorges, headwall swales, stream banks, existing landslides, and other locations identified in the field. Because of the high risk of landsliding inherent in these features, any activity that might trigger an erosional event should be avoided, if possible, and kept to a minimum if unavoidable. Such activities include road building, timber harvesting, yarding, terracing for vineyards, etc.

Analysis of chronic landsliding in the Noyo River basin indicated that landslides observed on aerial photographs largely coincide with predicted chronic risk areas including steep slopes, inner gorges, and headwall swales (Dietrich et al., 1998). Several other studies have shown that landslides are larger or more common in some harvest areas, particularly in inner gorges (Graham Matthews & Associates, 2001). Weaver and Hagans (1994) also suggest methods for eliminating or decreasing the potential for road-related sediment delivery.

Disturbed Areas

Desired Condition: decrease in disturbed area, or decrease in disturbance index
The areal extent of disturbed areas is an indication of increased sediment loads, particularly chronic sediment discharges that are not associated with large storms or floods. Studies in Caspar Creek (Lewis, 1998) indicate a statistically significant relationship between disturbed areas and the corresponding suspended sediment discharge rate (Lewis, 1998; Mangelsdorf and Clyde, 2000). In addition, studies in Caspar Creek indicate that clear cutting causes greater increases in peak flows (and, by extension, increased suspended sediment loads) than does selective harvest (Ziemer, 1998). As with the "hydrologic connectivity" desired condition, increases in peak flows, annual flows, and suspended sediment discharge rates negatively affect the potential survivability of salmonid eggs in redds (Lisle, 1989).

Available information is not sufficient to identify a threshold below which effects on the Scott River watershed would be insignificant. Accordingly, the desired condition calls for a reduction in the amount of disturbed area or in the disturbance index. In this context, "disturbed area" is defined as the area covered by urban development or management-related facilities of any sort, including: roads, landings, skid trails, fire lines, timber harvest areas, animal holding pens, and agricultural fields (e.g., pastures, vineyards, orchards, row crops, etc.). The definition of disturbed area is intentionally broad to include managed agricultural areas, such as pastures and harvest areas, where the management activity (e.g., logging or grazing) results in removal of vegetation sufficient to significantly reduce rainfall interception and other soil protection functions. Agricultural fields or harvest areas in which adequate vegetation is retained to perform these ecological functions are not considered disturbed areas. Dramatic reductions in the amount of disturbed area can be made by reducing road densities, skid trail densities, clearcut areas, and other management-produced bare areas.

Human intervention can affect both the frequency and the intensity of fires, but staff have not made an attempt here to address this complex issue. For the purpose of this study, fire is assumed to be a natural process and is not taken into account.

Road density is also considered by many researchers to be an important indicator of the potential for sediment delivery to streams. Roads create impervious surfaces which result in increased surface runoff and peak flows. A watershed analysis performed as part of a long term strategy for Lassen National Forest Land (Armentrout et al., 1998) cited a road density of 2.5 miles of road per square mile of land as a watershed management objective indicating overall system conditions on at the subwatershed scale. The Scott River TMDL Action Plan does not propose road density as a specific desired condition for the Scott River watershed, although a decreasing trend in road densities would be beneficial. Information on road density by subwatershed is presented in Chapter 3.

2.4.2 Instream Sediment Conditions in the Scott River Watershed

Available data on instream sediment conditions mostly represent the mainstem Scott River, several tributaries in the canyon reach (Tompkins, Boulder, and Canyon creeks) and several westside tributaries (Shackleford-Mill, Etna, French, and Sugar creeks). Available data on instream sediment conditions on the mainstem Scott River through Scott Valley show a consistent pattern of impairment, through with indications of improving trends for some parameters. Westside tributaries show mixed conditions, with some parameters exceeding desired conditions, some meeting desired conditions, and some with stable or improving trends in fine sediment values. For canyon tributaries, available data are generally indicative of sediment impairment.

A summary of instream sediment conditions in the Scott River watershed is listed in Table 2.5, which also includes desired conditions values taken from Table 2.2. A more detailed discussion of instream sediment conditions for individual parameters is found in the following sections. These sections are presented in alphabetical order. The order is not intended to convey relative importance of any individual parameter.

2.4.2.1 Benthic Macroinvertebrate Assemblages

Quigley (2001) conducted a macroinvertebrate survey at five localities on the mainstem Scott in October, 2000 and April, 2001. The sites are:

a) Red Bridge, just below where the South Fork and the East Fork meet and upstream of the dredge tailings.
b) ISSCR (T44N R9W Sec 26), in the middle part of Scott Valley downstream of the dredge tailings and in the major agricultural area.
c) Meamber (T44N R10W Sec 26), eight miles downstream of Fort Jones, just upstream of the mouth of the canyon. This site was chosen to show the cumulative impact of upstream farming practices.

Table 2.5
Instream Sediment Conditions in the Scott River Watershed

Parameter	Desired Condition	Applicability	Assessment of Available Data
Benthic Macroinvertebrate Assemblage	≥ 18 Index Score per the Russian River Index of Biological Integrity (IBI). See Table 2.3 for the Russian River IBI.	1st, 2nd, and 3rd Order Streams.	Quigley concludes that benthic data indicate degraded water quality through the valley during the summer months, although conditions improve over the course of the winter.
Embeddedness	Increasing trend in the number of locations where gravels and cobbles are ≤ 25% embedded.	All wadeable streams and rivers.	Data limited. Results from 1989 for Scott River and streams in the canyon reach show high percent of locations exceed 25% embedded. Scott River results indicate watershed-scale impairment for this indicator.
Large Woody	Increasing trend in	Streams and rivers with bankfull	Data collected for Siskiyou RCD available but

Table 2.5
Instream Sediment Conditions in the Scott River Watershed

Parameter	Desired Condition	Applicability	Assessment of Available Data
Debris (LWD)	the volume and frequency of LWD and key pieces of LWD.	channel widths > 1m.	cannot be evaluated against LWD key piece criteria.
Pools – Backwater Pool Distribution	Increasing trend in the number of backwater pools.	Wadeable streams and rivers with channel morphology that supports the development of backwater pools. Steep, v-shaped valleys with little floodplain connection generally do not exhibit this type of habitat and are exempt from this index.	No data.
Pools – Lateral Scour Pool Distribution	Increasing trend in the number of lateral scour pools.	Wadeable streams and rivers with channel morphology that supports the development of backwater pools. Steep, v-shaped valleys with little floodplain connection generally do not exhibit this type of habitat and are exempt from this index.	No data.
Pools – Primary Pool Distribution	Increasing trend in the number of reaches where the length of the reach is composed of ≥ 40% primary pools.	All wadeable streams and rivers.	Available data on both the mainstem Scott and tributaries do not meet the desired condition in any reach measured.
Percent Fines	≤ 14% fines < 0.85 mm in diameter. ≤ 30% fines < 6.40 mm in diameter.	Wadeable streams and rivers with a gradient < 3%.	Available data indicate stable or improving trends in the 0.85 mm indicator and that the desired condition is generally met. The 6.4 mm desired condition is generally not met, including in the mainstem from French Creek to Shackleford Creek, and in French, Sugar, Canyon and Tompkins Creeks. The 6.4 mm desired condition was met in Etna Creek.
Thalweg Profile	Increasing variation in the thalweg elevation around the mean thalweg profile slope.	Streams and rivers with slopes ≤ 2%.	Data not adequate for assessment.

d) Johnson Bar (T45N R 10W Sec 21), just above the mouth of the Scott River. This site is in the first spawning reach available to Chinook salmon in the fall.
e) Below the mouth of Middle Creek (T44N R11W), below the mouth of Canyon and Kelsey Creeks. Site chosen to show influence of water contributed by free-flowing canyon tributaries that mitigate some of the effects of agriculture.

The biotic indices used by Quigley (2001, p. 6) are:

Taxa Richness - This reflects the number of distinct taxa within a sample. The more diverse the sample, the healthier the habitat indicated. Taxa richness values decrease as the diversity of the sample decreases.

EPT Taxa - Number of taxa in the insect orders Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies). These are the most common taxa of intolerant invertebrates. This number also decreases with disturbance of habitat.

Tolerance Value - This value is a measure of the number of species considered tolerant to pollution. As the health of the habitat decreases, this value increases.

%Dominance - Measures the dominance of the single most abundant taxon. As the habitat quality gets worse, the most tolerant species will increase in numbers, and the % Dominance value will increase.

Modified EPT and Shannon Diversity indices were also reported.

Quigley (2001, p. 8) concludes that samples collected for the project demonstrate degraded water quality through the valley during the summer months, although conditions improve over the course of the winter.
Another measure of the biological health of a stream is the Russian River Index of Biological Integrity (Table 2.3). This measure uses the same biological metrics as the work of Quigley and combines all the metrics into a single score. If the work of Quigley (2001) is considered to be background information, future studies might build upon it by using the Russian River Index of Biological Integrity. Ongoing work on macroinvertebrates by the State Water Board and researchers at Utah State may also provide indicators appropriate to the North Coast.

2.4.2.2 Embeddedness Conditions

The U.S. Forest Service has compiled embeddedness figures for the Scott River and four tributaries within the Klamath National Forest (Table 2.6). The Scott River, with an average of thirty-five percent embeddedness and fifty-four percent of sites exceeding the desired condition value of ≤ 25% embeddedness, showed that the basin as a whole was impaired at the time the measures were made in 1989. Results for Tompkins and Canyon Creeks indicated high embeddedness values at most sites, and average values above the desired condition. Two tributaries, Shackleford and Mill Creeks, showed only mild impairment.

Quigley (2003) reports data on embeddedness from 4 mainstem locations and 24 locations on 8 tributaries (Boulder, Emigrant, French, Mill/Shackleford, Miner's, Sugar and Wildcat Creeks). Results indicate generally high values except in Miner's Creek, Wildcat Creek, the tailings reach, and some locations in French Creek.

Table 2.6
Embeddedness of Gravels in the Scott River & Four Tributaries*

USFS Survey #	Name of Stream	# of Measure-ments	Average % Embeddedness	Range of % Embeddedness	# >25% Embedded	% >25% Embedded
39	Scott River	239	35	0-95	128	54
119	Tompkins Creek	12	33	0-50	10	83

101	Canyon Creek	25	48	0-75	23	92
33	Shackleford Creek	46	13	5-40	2	4
25	Mill Creek	12	10	10-50	1	8

* Data supplied by the USFS. Data gathered in 1989.

2.4.2.3 Large Woody Debris (LWD) Conditions

No systematic analysis of LWD conditions in the Scott River watershed is currently available. Table 2.7 shows an accepted procedure for determining LWD effectiveness. A protocol such as is shown in Table 2.7 would be an appropriate beginning to evaluate the status of LWD in the Scott River and tributaries.

2.4.2.4 Pool Distribution and Depth Conditions

Habitat data cited in the Noyo River Total Maximum Daily Load for Sediment (USEPA, 1999, p. 38-39) all indicate that pool frequency and/or pool depth may be factors limiting the success of salmonids. Deep and frequent pools are necessary as summer rearing habitat, particularly for coho salmon, which are less able than steelhead trout to compete for food supplies in the absence of deep pools (Harvey and Nakamoto, 1996).

Flosi et al. (2004, p. V-15) reported:

> DFG habitat typing data indicate the better coastal coho streams may have as much as 40 percent of their total habitat length in primary pools. In first and second order streams a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low-flow channel, and be as long as the low-flow channel width. In third and fourth order streams the criteria is the same, except maximum depth must be at least three feet.

A review of habitat typing data collected since 1993 indicates that the better coho streams in California generally have about 40 percent of their total habitat length in primary pools (USEPA, 1999, p. 39). Using this criterion, the numeric desired condition for pool frequency/depth requires that at least forty percent of the total habitat length be in three-foot-deep pools.

Table 2.7
LWD Key Piece Volume Criteria
(taken from Schuett-Hames et al., 1999; modified with results from Fox, 2001)

Min. Diameter in meters	Minimum Length of LWD in meters			
	BFW > 0 to < 5	BFW 5 to < 10	BFW 10 to < 15	BFW 15 to < 20
0.20	32			
0.25	21			
0.30	15	36		
0.35	11	26		
0.40	8	20		
0.45	7	16	38	
0.50	6	13	31	
0.55	5	11	26	
0.60	4	9	22	32
0.65	3	8	19	28
0.70	3	7	19	24
0.75	3	6	14	21
0.80	2	5	12	18
0.85	2	5	11	16
0.90	2	4	10	15
0.95	2	4	9	13
1.00	2	4	8	12
1.05	2	3	7	11
1.10	2	3	7	10
1.15	1	3	6	9
1.20		3	6	8
1.25		3	5	8
1.30		2	5	7
1.40		2	4	6
1.55		2	4	5
1.60		2	3	5
1.70		2	3	4
1.80		1	3	4
2.00			2	3
2.40			2	2
2.80			1	2
3.40				1

Meter/Feet conversion: meters x 3.281 = feet

Minimum LWD Volume to Qualify as a Key Piece

BFW (m)	Volume (m^3)
0 to < 5	1
5 to < 10	2.5
10 to < 15	6
15 to < 20	9
20 to < 30	9.75
30 to < 50	10.5*
50 to 100	10.75*

* Wood piece must have an attached root wad.

Procedure:
1. Select segment bankfull width (BFW) category.
2. Measure diameter of candidate pieces and round to nearest 0.05 m (5 cm)
3. Follow matrix across to find the minimum length requirement.

Key Log Example:
1. Segment has an average BFW of 12 m (use BFW column of 10 to < 15 m).
2. Candidate log diameter is measured/ estimated to be 0.53 m (round to 0.55 m).
3. Log must be a minimum of 26 m long (measure/estimate log length to assess if it is a key piece).

Key Rootwad Example:
1. Segment has an average BFW of 4 m (use BFW column of 0 to < 5 m).
2. A rootwad Key Piece must have a minimum diameter of 1.15 m and length of 1 m.

The Siskiyou RCD (2003) recorded pool occurrence in five reaches of the Scott mainstem and five tributaries. The five reaches of the mainstem ranged from nine percent to thirty percent pools by length and averaged twenty percent. Twenty reaches recorded on the five tributaries ranged from zero percent to fifteen percent pools by length, and averaged six percent pools. This study did not specify depth of pools and some pools may have been less than three feet deep.

Quigley (2003) included data on pools in four reaches of the Scott mainstem and twenty-four reaches on eight tributaries. In this study, the four reaches of the mainstem ranged from nine percent to thirty-four percent pools by length (with the highest value in the tailings reach), and by reach from forty-seven percent to 100 percent of these pools were three feet deep or deeper. In the twenty-four tributary reaches, values ranged from zero percent to twenty percent pools by length.

2.4.2.5 Percent Fines Conditions

In this section, the discussion is broken out by drainage first. Within each drainage discussion, results related to the 6.4mm desired condition are discussed first, followed by results related to the 0.85 mm desired condition. Most of this discussion is based on results presented in Sommarstrom and others (1990) and Sommarstrom (2001), reporting on sampling performed in 1989 and 2000. All samples in both years were collected with a McNeil sampler.

Mainstem Scott River

Sediment size was analyzed from twelve sites in the mainstem Scott River distributed from River Mile (RM) 23.5 to RM 55.7 (in 1989 and 2000. This part of the river is of low gradient and passes through the open agricultural part of Scott Valley Analyses showed more than 30 percent fines <6.3 mm at 9 of 11 sites in 1989 (one site not sampled) and at 10 of 12 sites in 2000. In 1989 the fraction <6.3 mm ranged from 26.8 percent to 92.7 percent; in 2000 that size category ranged from 18.3 percent to 84.3 percent. A comparison of the two sample sets shows increases at 4 sites, decreases at 3 sites, and values about the same at 4 sites. Sediment in the mainstem Scott does not reach the desired condition of $\leq$ 30 percent fines < 6.4 mm in the reach between French Creek and Shackleford Creek. Sommarstrom and others (1990) showed that much of the sand-sized sediment is generated in the areas of decomposed granitic soil in areas on the west and south sides of the watershed, and that disturbance of these areas by management greatly increases their sediment contribution.

At the same sites on the mainstem Scott River, analyses showed more than 14 percent fines <0.85 mm at four of 11 sites in 1989 (one site not sampled) and at 2 of 12 sites in 2000. In 1989 the fraction <0.85 mm ranged from 6.4 percent to 21.6 percent, but in 2000 the range of that size category ranged had decreased to 4.0 percent to 16.8 percent. The biggest improvements were measured in the reach between Etna Creek and Moffett Creek.

Etna Creek

In 2000, samples were collected at one site in Etna Creek, two in French Creek, and one in Sugar Creek, for comparison to sites sampled in 1989. The Etna Creek site, at the Highway 3 bridge, showed the fraction ≤ 6.3mm to be 28.3 percent in 1989 and 16.9 percent in 2000. These values meet the desired condition of ≤ 30 percent in both years and show an improving trend. The fraction ≤ 0.85mm was 5.1 percent in 1989 and 7.4 percent in 2000. These values met the desired condition of ≤ 14 percent in both years.

French Creek

In 1989, three locations were sampled in French Creek. Two of the three samples exceeded 30 percent sediment <6.3mm and did not meet the desired condition of ≤ 30 percent < 6.4mm. Sommarstrom (2001) reported sampling of locations at the Highway 3 and Miner's Creek Road bridges over French Creek. At both locations the fraction of sediment ≤ 6.3mm exceeded 30 percent in 1989 and 2000. All of the three locations sampled in 1989 showed < 14 percent sediment < 0.85mm, meeting the desired condition of ≤ 14 percent. Samples from the two locations resampled in 2000 also met the desired condition.

Sugar Creek

Samples were collected near the mouth below the Highway 3 bridge in 1989 and 2000. The fraction of sediment ≤ 6.3mm was 30.8 percent in 1989, and 33.8 percent in 2000. The fraction ≤ 0.85 mm was < 14 percent in both locations in both years, though slightly higher in 2000.

Canyon Creek

Lester (1999) analyzed sediment from nine sites in Canyon Creek, which drains an area containing some granitic soils. Lester did not use a 6.4 mm screen, but instead used 4.75 mm and 8 mm screens. These data show >30 percent sediment ≤6.4 mm at four of 12 sites and >14 percent fines ≤0.85 mm at none of 9 sites. This creek appears somewhat impaired in regard to fine sediment.

Tompkins Creek

Lester (1999) analyzed sediment from nine sites in Tompkins Creek, which drains an area containing some granitic soils. These data show >30 percent sediment ≤6.4 mm at four sites and >14 percent fines ≤0.85 mm at one site. In summary, results at the locations sampled appear to indicate improving trends from 1989 to 2000 for the fraction <0.85 mm, but show continued patterns of exceedance and no clear trend of improvement for the fraction <6.4 mm.

2.4.2.6 Thalweg Profile Conditions

No systematic information on thalweg profiles is available in the Scott River watershed. One study by University of California Davis (2003) surveyed reaches in Mill Creek (4), Emigrant Creek (3), French Creek (5), Sugar Creek (5), and the East Fork (5). Example results of longitudinal profiles and cross sections are presented, though comparisons through time are not made. Sommarstrom and others (1990, p. 3-9 to 3-14) measured cross sections at 15 locations from above Callahan to the Scott River gage station near Fort Jones. The report (Figure 3-10) compares cross sections at the Highway 3 bridge from 1956 and 1989, and finds the thalweg elevations are similar.

2.4.2.7 V* Conditions

Before 1992 excess fine sediment was acknowledged to be a significant problem in French Creek. V* analyses were done in French Creek yearly from 1992 to 1997 and again in 1999 and 2001 (Figure 2.4). The number of pools sampled each year ranged from 11 to 13.

More than sixty percent of the French Creek drainage basin is underlain by DG, which ravels and contributes abundant sediment to streams (e.g. Sommarstrom, 1992). By the early 1990s management activities had disturbed large areas in the basin. In 1992 a major restoration and reclamation effort began that included, among other steps, repairing and redesigning road crossings, outsloping roads, and decommissioning some roads. A major decline in fine sediment in the following years appears to be the direct result of that initiative. In 1997, a major storm led to flooding and abundant sediment contribution. However, the V* values rose to only about fifty percent of what they had been in 1992. The restoration work that began in 1992 appears to be quite effective in decreasing the sediment contribution to French Creek.

The U.S. EPA, in the South Fork Trinity River and Hayfork Creek TMDLs (U.S. EPA, 1998a, Table E-2), includes a mean V* desired condition value of ≤ 0.10 for tributaries that drain watersheds composed of the metamorphic and intrusive basement of the Klamath Mountains geologic province, which includes the Scott River watershed. The U.S. EPA states that background values of 0.10 to 0.15 would be expected for Klamath Mountains geology (Lisle, USFS, pers. comm., 1998, as cited in U.S. EPA, 1998a, Table E-1). Assuming that a mean V* value of ≤ 0.10 represents healthy background conditions in the Scott River watershed, data from French Creek indicate improving trends in V*, and values that meet or are near to meeting the ≤ 0.10 value. There are no data available for the mainstem Scott River or other tributaries.

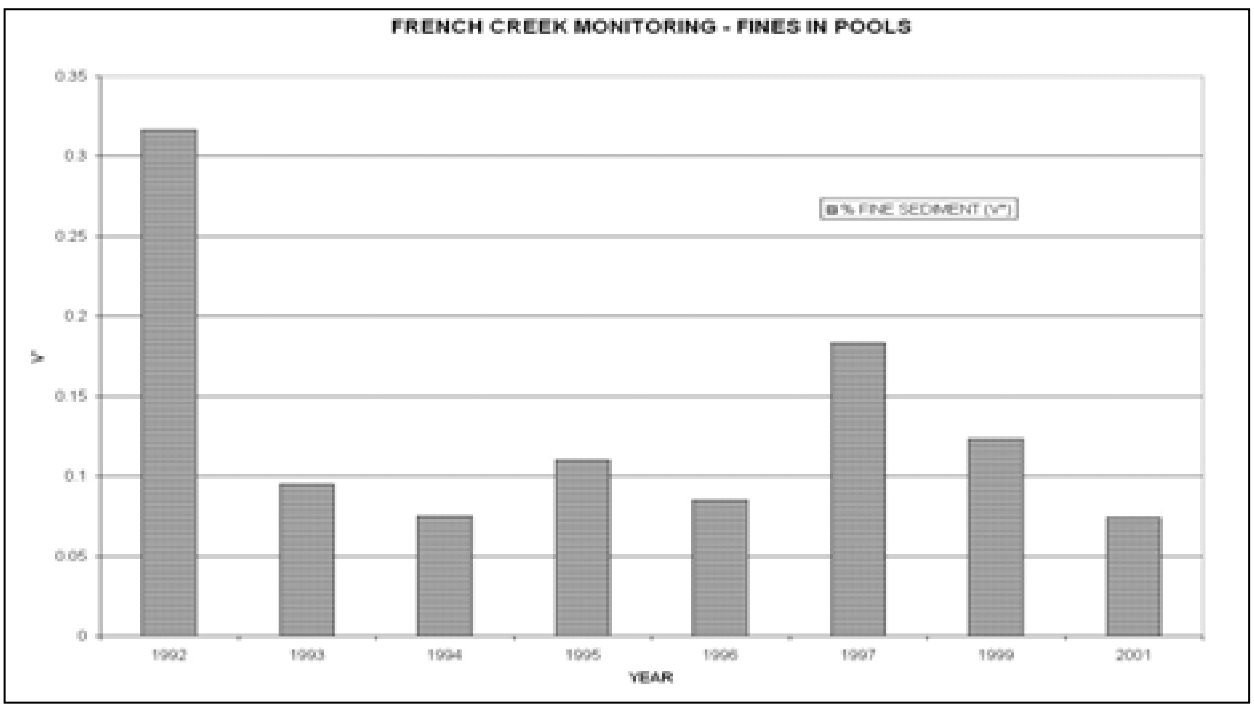

Figure 2.4. French Creek Monitoring Results – Fine Sediment in Pools (V*)

Juvenile coho surveys done in French Creek from 1992, the time of the French Creek Project, are discussed in Section 2.3 and indicate an increasing trend in coho coincident with the beginning of improvement in sediment conditions in the stream.

2.4.3 Watershed Sediment Conditions in the Scott River Watershed

The hydrology and surface conditions in the Scott River watershed have been affected over time by several intense management activities. The upslope conditions in the Scott River watershed have been altered by human activities in many ways, some of them reversible and some, such as effects of some aspects of mining activities, virtually irreversible. The following sections describe some of these processes, the conditions they create, and recently documented trends.

2.4.3.1 Stream Crossings with Diversion Potential or Significant Failure Potential

The USFS has done a road sediment source inventory that includes sites in the Scott River watershed (USFS, 2001). Diversion potential was estimated at 38% of channel crossing sites in the Lower Scott survey area (mostly in the West Canyon subwatershed, as defined in chapter 3), and at 36% in the Upper Scott survey area (all in the West Headwater (South Fork) subwatershed).

A road erosion inventory in the Shackleford and Mill Creek watersheds (SHN Consulting Engineers & Geologists, 1999) mapped 107 miles of forest roads on private timberlands. The road density is approximately 8.9 miles per square mile. Culverts, crossings, gullies, slides, and road surface erosion were inventoried and evaluated for past erosion and possible future erosion. Sites and road segments farther than ¼ mile from a fish-bearing stream were not considered. Features surveyed included 164 culverts, 186 crossings, 82 gullies, and 50 slides. Estimated volume of past erosion, not including mass movement, was 19,700 cubic yards. This inventory identifies 487 features in the four point-source categories, of which 121 are evaluated as high or medium-high priority for treatment.

The follow-up Shackleford-Mill Road Erosion Reduction Project (Siskiyou Resource Conservation District, 2003) treated 30 miles of roads to reduce sediment production. The program hydrologically decommissioned 6.9 miles of road and improved the remainder to reduce sediment contribution. Measures consisted primarily of storm-proofing road segments and crossings, and out-sloping roads. The 219 sites treated had the potential to deliver 73,000 cubic yards of sediment.

A road survey in the upper Etna Creek drainage and adjacent areas in Clark Creek, North Fork French Creek, and upper French Creek (Resource Management, 2003) examined approximately 100 miles of road. The area has had extensive timber harvest, and harvest continues, but we do not know the most recent harvest history. Generalizations summed up in this study are:

- 91% of past erosion has been on 25 percent of the road miles.

- Only 20-30% of smaller culverts in the area (12, 18, 24 inch) pass for a 100-year flow design; however small errors in drainage area calculations or assumptions regarding infiltration can have large effects on results, so more investigation is needed.
- Culverts 36" and larger passed 100 year flow design at 50% and higher.
- New road construction and ongoing maintenance techniques are effective.
- Effective use of low water crossings and bridges reduced diversion potential and increased the number of crossings passing 100-year flows.

The Preliminary Road Maintenance Action Plan calls for a) specific erosion site plans, b) company 5-year planning schedule, c) company road maintenance procedures, d) workable cooperative road agreements. The report notes and prioritizes specific problem sites.

2.4.3.2 Hydrologic Connectivity

SHN (1999) recommends upgrading major segments of roads in the Mill and Shackleford Creek drainages. The SHN (1999) road inventory does not record whether a road segment has inboard ditches, but their map of Erosion and Crossing Locations shows many culverts that are not in natural drainages, suggesting an extensive inboard ditch system and little outsloping. They do not describe the culverts and to what degree they are "shotgunned."

The USFS has done a road sediment source inventory that includes sites in the Scott River watershed (USFS, 2001). The results indicate hydrologic connectivity values of 12.3% and 21.8% in the upper and lower Scott survey areas, respectively.

2.4.3.3 Annual Road Inspection and Correction

The USFS and timber companies maintain roads on a project basis, repairing and upgrading roads in limited areas on a project rather than on a widespread annual basis. Over time, the trend is toward an increasing proportion of outsloped roads, although a large proportion of roads remain in ditch-and-culvert design. One timber company is currently embarking on a long-term road management plan as part of a Habitat Conservation Plan. Other private roads appear to be maintained on an as-needed basis. The SHN study (SHN 1999, p. 14) survey notes that many road segments have had little or no annual maintenance for years.

2.4.3.4 Road Location, Surfacing, & Sidecast

The road erosion inventory of Shackleford and Mill Creek watersheds (SHN Consulting Engineers and Geologists, 1999) does not quantify the miles of road adjacent to streams, but the included map shows gravel surface roads in inner gorges within 600 feet of both Shackleford and Mill Creeks. In this heavily roaded area many logging roads lie on lower slopes and in headwall areas. The inventory document recommends much upgrading of culverts and crossings, and sets priorities, but does not address outsloping of roads.

Information on road proximity to streams was developed as part of the sediment source analysis and is presented in Chapter 3.

2.4.3.5 Disturbed Areas

The earliest major disturbance in the Scott River watershed was placer mining for gold, which started at Scott Bar in 1850 and soon spread throughout much of the watershed. The story of this mining, summarized by the Scott River Watershed CRMP Committee (1995), is a story of placer mining that included deep dredging and hydraulic mining. Resulting sediment plumes impeded fish surveys as late as 1934, and in 1934 a federal fishery biologist reported that upstream of Callahan food and spawning grounds had been destroyed. During development of mining, extensive ditches were constructed. Later, these ditches were used for developing agriculture. Much of the agriculture is grazing and hay cropping, which does not qualify as disturbed areas under the present definition. Timber harvest began along with mining, and continues on an industrial scale to the present. Logging roads are a major source of sediment, and they contribute a particularly large amount in areas of decomposed granite (DG) soils (Sommarstrom et al., 1990; Sommarstrom et al., 1999).

2.5 TEMPERATURE PROBLEM STATEMENT

This section describes the freshwater temperature requirements for salmonids, recommended criteria for summer salmonid rearing, desired conditions, and temperature conditions in the Scott River watershed.

2.5.1 Salmonid Temperature Requirements

Temperature is one of the most important factors affecting the success of salmonids and other aquatic life. Most aquatic organisms, including salmon and steelhead, are poikilotherms, meaning their temperature and metabolism are determined by the ambient temperature of water. Temperature therefore influences growth and feeding rates, metabolism, development of embryos and alevins, timing of life history events such as upstream migration, spawning, freshwater rearing, and seaward migration, and the availability of food. Temperature changes can also cause stress and mortality (Ligon et al., 1999).

Much of the information reported in the literature characterizes temperature requirements with terms such as “preferred” or “optimum” or “tolerable.” Preferred temperatures are those that fish most frequently inhabit when allowed to freely select temperatures in a thermal gradient (McCullough, 1999). An optimum range provides for feeding activity, normal physiological response, and normal behavior (without symptoms of thermal stress) (McCullough, 1999). A tolerable temperature range refers to temperatures at which an organism can survive.

Most interpretations of water temperature effects on salmonids and, by extension, water temperature standards, have been based on laboratory studies. Many studies have also looked at the relationship of high temperatures to salmonid occurrence, abundance, and distribution in the field.

As discussed above, several species of anadromous fish utilize the Scott River watershed at some point within in their life cycle, including various salmonid species. A complete review of the literature pertaining to the temperature requirements for the various life stages of steelhead trout (*Oncorhynchus mykiss*), coho salmon (*O. kisutch*) and chinook salmon (*O. tschawytscha)* is presented in *The Effects of Temperature on Steelhead Trout, Coho Salmon, and Chinook Salmon Biology and Function by Life Stag, Implications for Klamath Basin TMDLs* (Carter, 2005*)*. When possible, species-specific requirements were summarized by four life stages: migrating adults, spawning, embryo incubation and fry emergence, and freshwater rearing. Some of the references reviewed covered salmonids as a general class of fish, while others were species specific.

2.5.1.1 Temperature Metrics

It is useful to have measures of chronic and acute temperature exposures for assessing stream temperature data. An USEPA document, *Temperature Criteria for Freshwater Fish: Protocol and Procedures* (Brungs and Jones, 1977) discusses development of criteria for assessing temperature tolerances of fish for several different life stages. Two measures of exposure are developed and applied: maximum weekly average temperature (MWAT) as a measure of chronic exposure and short-term maximum temperature as a measure of potentially lethal effects.

The MWAT is the maximum value of the mathematical mean of multiple, equally spaced, daily temperatures over a 7-day consecutive period (Brungs and Jones, 1977). In different words, this is the highest value of the 7-day moving average of temperature. Brungs and Jones developed MWAT metrics for the growth phase of fish life, as growth appears to be the life stage most sensitive to modified temperatures and it integrates many physiological functions. They also developed life stage MWAT metrics for spawning.

Sullivan and others (2000) review sub-lethal and acute temperature thresholds from a wide range of studies, incorporating information from laboratory-based research, field observations, and risk assessment approaches. The authors report calculated MWAT metrics for growth ranging from 14.3° C to 18.0° C (57.7° F to 64.4 ° F) for coho salmon, and 14.3° C to 19.0° C (57.7° F to 66.2° F) for steelhead trout. The risk assessment approach used by Sullivan and others (2000) suggest that an upper threshold for the MWAT of 14.8° C (58.6° F) for coho and 17.0° C (62.6° F) for steelhead will reduce growth 10 percent from optimum, and that thresholds for the MWAT of 19.0° C (66.2° F) for both coho and steelhead will reduce growth 20 percent from optimum.

While these thresholds relate to reduced growth, temperatures at sub-lethal levels also can effectively block migration, inhibit smoltification, and create disease problems (Elliot, 1981). Further, the stressful impacts of water temperatures on salmonids are cumulative and positively

Table 2.8
Recommended Criteria for Summer Maximum Water Temperatures

Use	Criteria	
	7-DADM	MWAT
Salmon / Trout "Core" Juvenile Rearing (*Salmon adult holding prior to spawning may also be included in this use category*).	16°C / 60.8°F	14.5°C / 58.1°F
Salmon/Trout Migration	18°C / 64.4°F	16.1°C / 70.0°F

plus Non-Core Juvenile Rearing.		
Salmon/Trout Migration.	20°C / 68.0°F	17.7°C / 63.9°F

Notes:
1) "Salmon" refers to chinook, coho, sockeye, pink, and chum salmon. "Trout" refers to steelhead and coastal cutthroat trout.
2) "7-DADM" refers to the Maximum 7-Day Average of the Daily Maximums.
3) Source: U. S. Environmental Protection Agency (2003a, p.25).

correlated to the duration and severity of exposure. The longer the salmonid is exposed to thermal stress, the less chance it has for long-term survival (Ligon et al., 1999).

Jobling (1981) reported that the upper lethal limit, that is, the temperature at which death occurs within minutes, ranges from 27° C to 30° C (80.6 F to 86.0° F) for salmonids. Sullivan and others (2000) report acute threshold values, that is, temperatures causing death or total elimination of salmonids from a location, that range from 21.0° C to 25.5° C (69.8° F to 77.9° F) for coho, and 21.0° C to 26.0° C (69.8° F to 78.8° F) for steelhead.

The MWAT is used as the primary statistical measure for interpretation of stream temperature conditions in the summary of stream temperature data in the Scott River watershed. USEPA Region 10 has issued guidance regarding temperature criteria protective of cold water fish for various species and life-stages. These values are included here to aid with interpretation of watershed data. Because USEPA values are presented for the maximum 7-day averages of daily maxima (7-DADM), an MWAT equivalent value is included in Table 2.8 using correlation equation developed using temperature data from the Scott River watershed. The values in Table 2.7 are used for comparison to measured stream temperatures to characterize the temperature quality of surface waters in the Scott River watershed.

2.5.2 Temperature Desired Conditions

2.5.2.1 Effective Shade

Desired condition: Adjusted Potential Effective Shade Conditions from Riparian Vegetation
Effective shade is defined as the percentage of direct beam solar radiation attenuated and scattered before reaching the ground or stream surface from topographic and vegetation conditions. The desired shade conditions are those that result from achieving the natural mature vegetation conditions that occur along stream channels in the watershed, approximated as adjusted potential shade conditions as described in Section 4.5.1. The distribution of adjusted potential shade values is presented in Figure 4.29. A second approach to identifying the potential shade conditions at a site is detailed below.

To determine potential shade conditions provided by riparian vegetation for a particular stream reach in the watershed requires correlation of vegetation type, stream aspect, and active (unvegetated) channel width with effective shade. These relationships are functions of vegetation type, channel geometry, topography, and solar position.

Two models used to predict shade given channel characteristics as input were tested for use in estimating potential shade on a reach-by-reach basis. ODEQ has developed an Excel-based spreadsheet that allows calculation of effective shade as a function of vegetation height, stream aspect, active channel width, stream buffer width and buffer density. The spreadsheet is based on equations presented by Boyd (1996) and expanded for TMDL applications. USGS (Bartholow, 1999) also has a shade model.

The ODEQ spreadsheet, named SHADE, was selected for use in developing desired condition shade curves for different vegetation types occurring along riparian corridors of the Scott River and its tributary streams because it is better adapted for TMDL applications and has been used in the development of an approved temperature TMDL (ODEQ, 2000).

Effective shade desired conditions for the vegetation classes occurring in the watershed were set at 90% of the potential vegetation height for the class. Effective shade curves are presented for Douglas Fir (DFR) and Mixed Hardwood-Conifer (MHC) forest (40m), Klamath Mixed Conifer (KMC) and Ponderosa Pine (PPN) forest (35m), and Oak Woodland (20m) (Figures 2.5, 2.6 and 2.7) as an indicator of riparian conditions relative to a potential condition. Buffer widths are assumed to be 30m. The curves were developed for the July 22 solar path. The curves presented in Figures 2.4, 2.5 and 2.6 constitute the numeric targets for the temperature TMDL.

2.5.2.2 Thermal Refugia

Desired condition: Increased volume of thermally stratified pools
The desired condition is an increased volume of thermal refugia. Thermal refugia are sites that provide cold water habitat. The depth and degree of stratification is partly a function of stream flow and is expected to vary depending on site conditions. Thermally stratified pool volume can be expected to increase as existing stratified pools become deeper and shallow pools become deep enough to stratify in response to reduced sediment supply. Thermal refugia are also commonly found at the mouths of cold tributaries.

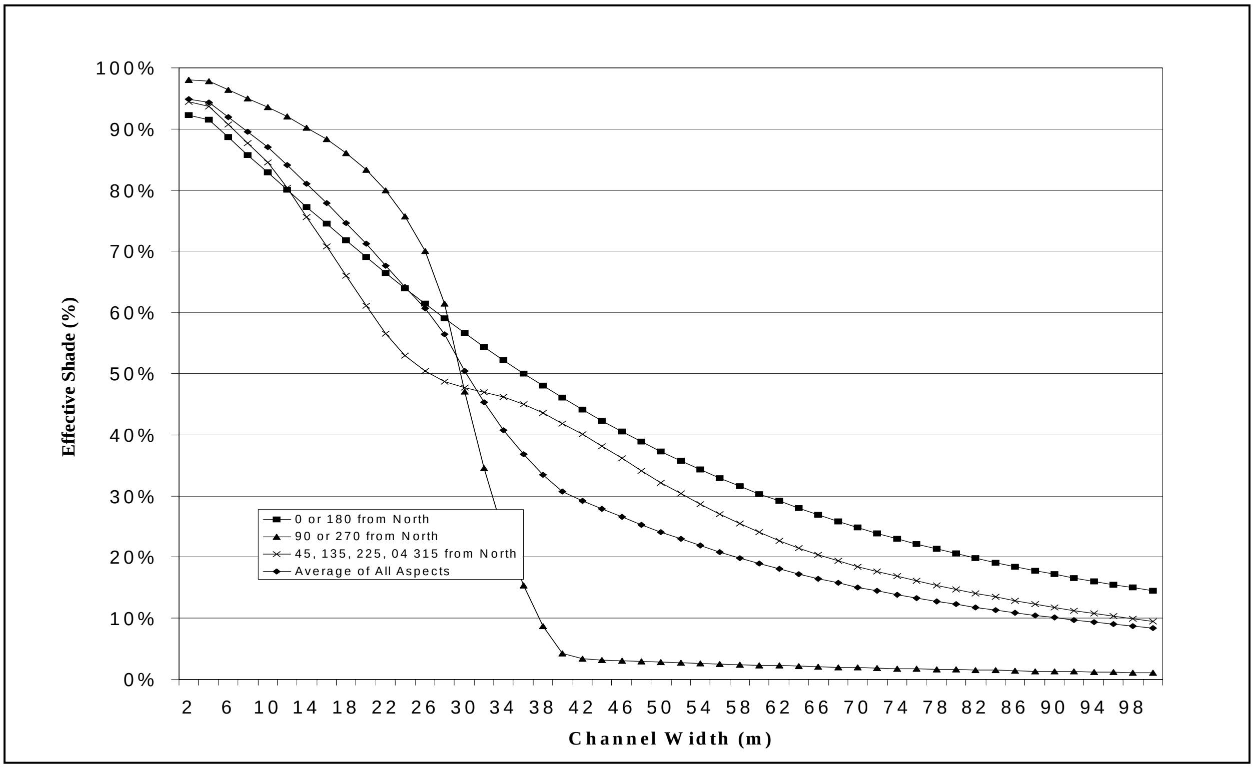

Figure 2.5: Effective Shade vs. Channel Width, Douglas Fir Forest (DFF) and Mixed Hardwood – Conifer Forest, Buffer Height = 40m

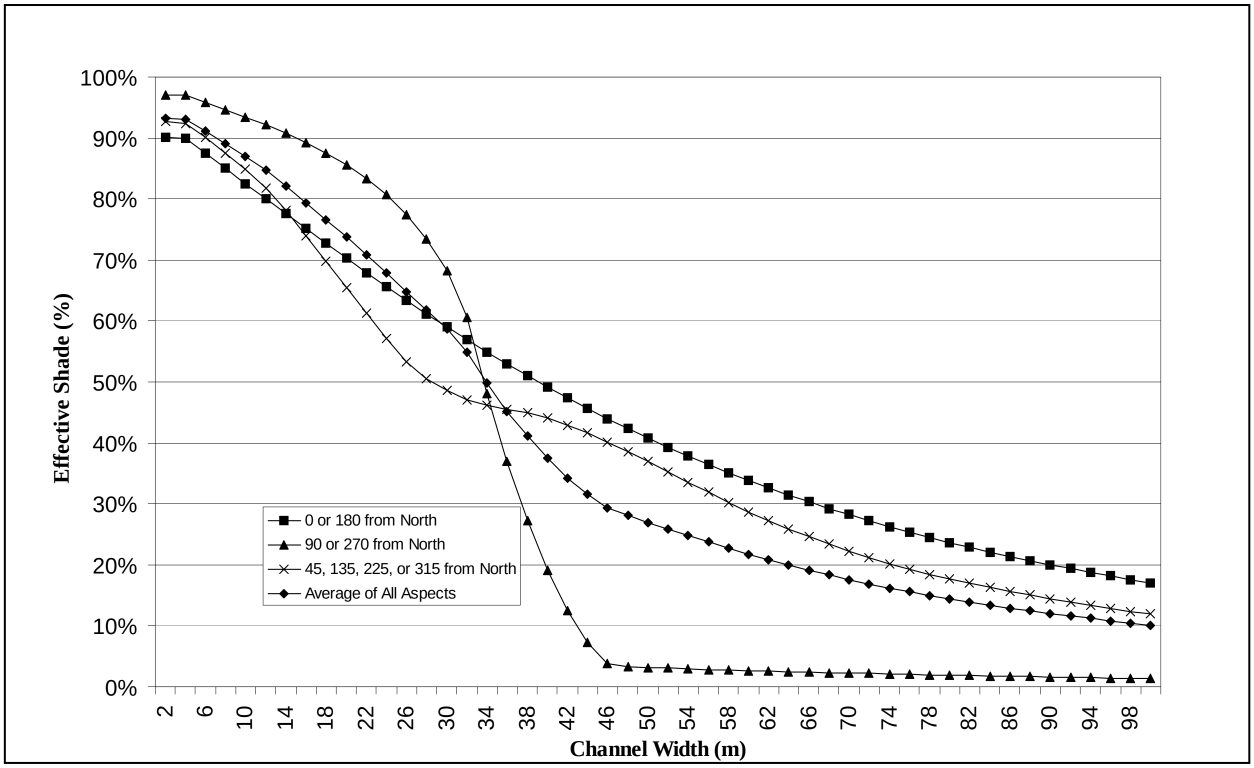

Figure 2.6 Effective shade vs. channel width, Klamath Mixed Conifer Forest (KMC) and Ponderosa Pine Forest (PPN), buffer height =35m

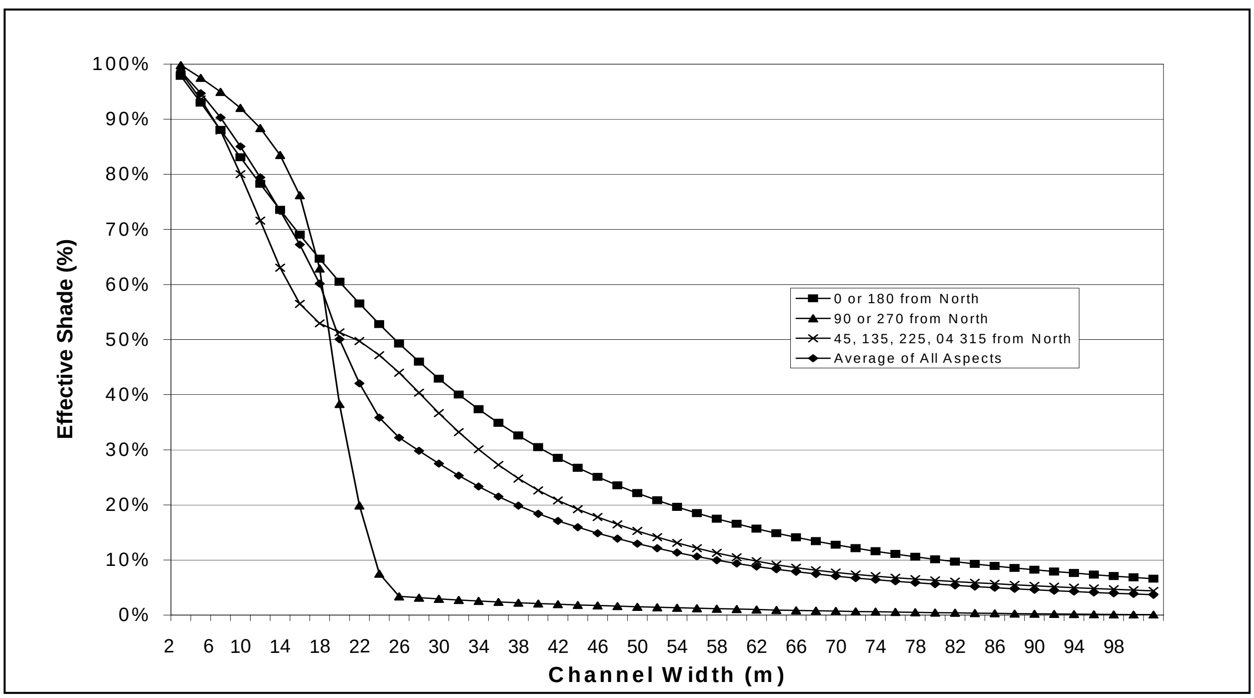

Figure 2.7. Effective shade vs. channel width, Oak woodland, buffer height =20m

2.5.3 Temperature Conditions in the Scott River Watershed

Unlike sediment-related objectives, stream temperature is a directly measurable water quality parameter and requires no indicator for interpretation of the water quality objective.

2.5.3.1 Summary of Temperature Conditions

Stream temperature data collected in the Scott River watershed since 1995 indicate that conditions vary throughout the watershed. A few generalities can be drawn based on these data:

1. Summer temperature conditions in the mainstem of the Scott River do not support suitable rearing habitat for salmonids.
2. Summer temperature conditions in the East Fork of the Scott River do not support suitable rearing habitat for salmonids.
3. Summer temperature conditions in the South Fork of the Scott River support suitable rearing habitat for salmonids in some years.
4. Summer temperature conditions in the upper reaches of many tributary streams in the Scott River watershed support rearing habitat for salmonids. These tributary streams include Lower Mill, Kelsey, Canyon, Boulder (canyon), Sniktaw, Shackleford, Mill (Shackleford tributary), Kidder, Etna, Etna-Mill, Clark, French, Sugar, Jackson, Fox, Boulder (west headwaters), Rail, and Kangaroo Creeks
5. Summer temperature conditions in the lower reaches of some tributary streams in the Scott River watershed, including Kelsey, Shackleford, Kidder, Patterson (west side), French, Wildcat, Etna, and Big Carmen Creeks do not support suitable rearing habitat for salmonids.
6. Summer temperature conditions in the upper reaches of Moffett Creek and Sissel Gulch do not support suitable rearing habitat for salmonids.

Stream temperatures vary considerably throughout the Scott River watershed in response to geomorphic and hydrologic characteristics. Quigley and others grouped streams in the Scott River watershed into six areas with similar geomorphic and hydrologic characteristics: the East Headwaters (East Fork watershed), West Headwaters (South Fork watershed), Scott Valley, Eastside, Westside, and Canyon. Water Board staff has summarized stream temperature conditions using the same groupings, except that the valley category has been replaced by the mainstem of the Scott River.

2.5.3.2 Scott River Mainstem

The temperatures in the Scott River are too high for suitable salmonid habitat conditions from the confluence of the East and South Forks to the mouth at the Klamath River. Starting at the confluence of the East and South Forks, the Scott River begins relatively warm. At river mile 55 the MWAT ranged from 20.4^{o} C (68.7^{o} F) to 17.1^{o} C (62.8 ^{o} F) in the years monitored (Table 2.9). The lowest MWAT measured in the Scott River was 17.0^{o} C in the tailings reach, near the upstream end of the river during 1998. The highest MWAT measured in the Scott River was 23.9 at Roxbury Bridge, near the mouth of the river, in 2003.

2.5.3.3 West Headwaters / South Fork Scott River

The West Headwaters of the Scott River, which consists of the South Fork Scott River and its tributaries, are located in the southwestern extremity of the Scott River Watershed. The West Headwaters have beneficial temperature conditions for salmonids, though the temperature rises into the unsuitable range in some years near the mouth of the South Fork of the Scott River (Table 2.10).

2.5.3.4 East Headwaters

The East Headwaters of the Scott River, which consists of the East Fork Scott River and its tributaries, are located in the southeastern extremity of the Scott River Watershed. The East Fork Scott River has temperatures that are warmer than the South Fork (Table 2.11). The East Fork MWATs are in the unsuitable range for salmonids. The middle and upper reaches of many of the perennial tributaries have temperatures cool enough to support salmonids.

2.5.3.5 Westside Tributaries

The Westside sub-basin tributaries have a wide range of measured MWAT temperatures (Table 2.12). Temperatures at three sites are suitable for salmonid habitat, while other sites have unsuitable temperatures, and yet others have suitable temperatures in some years and unsuitable temperatures in other years.

2.5.3.6 Eastside Tributaries

There is very little data for the eastside tributaries. There is only data available for two sites, both in the upper reaches of the Moffett Creek drainage (Table 2.13). Data from these two sites indicate that temperature conditions are unsuitable for salmonid habitat in most years.

2.5.3.7 Canyon Tributaries

The Canyon sub-basin tributaries exhibit a wide range of temperatures, from 10.9^{o} C in Patterson Creek, to 20.0^{o} C in Deep Creek (Table 2.14). The majority of measured tributary stream temperatures in this sub-basin indicate these tributaries are not fully supportive of salmonid habitat.

Table 2.9: Stream MWATs, Scott River Mainstem, 1995 – 2004

River			Maximum Weekly Average Temperature (C)								
Mile	**LOCATION**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
0.5	at Steelhead Bridge		22.8								
0.5	at Roxbury Bridge									23.9	
6.5	at McGuffy Creek		21.9	22.9	**21.8**						
10.8	at Townsend Gulch									22.6	
13.2	at Deep Creek			21.8						22.5	
14.3	below Kelsey Creek									22.2	
15.8	below Canyon Creek		21.2		**21.1**					22.4	
16.1	above Canyon Creek			22.7						23.3	
18.8	at Jones Beach		22.4		**22**					23.3	
21.6	at USGS Gaging Station	20.2			**21**					22.7	
	above Shackleford Creek							*18.6*			21.6
22.6	below Meamber Gulch								*21.2*		21.3
	at Meamber Creek 1					**19.8**	21.8				
	at Meamber Creek 2			23.1						22.5	
24.9	at Meamber Bridge								*21.4*	22.5	
25	at Meamber School			21.0		**19.8**					
31.9	at Eiler Ranch			21.7	**21.1**	**19.9**	22.5				
31.9	below Kidder								*23.7*	23.3	23.3
32.5	above Kidder Creek									23.6	
33.1	at Highway 3 Bridge			22.8		**21.2**					
35.1	at Island Road			23.1		**21**	23.6			23.2	
39.4	near Black Bridge								*22.0*	21.9	
41.5	at Eller Lane			22.1	**20.5**	**19.9**	22.5				
41.8	at Sweazey's Bridge									21.0	
42.3	above Sweazey's Bridge									20.3	
42.6	below Etna Creek			20.6	**20**		20.6				
42.9	above Etna Creek			20.7	**19.7**		17.2	*18.0*	*17.6*		
44.6	at Horn Lane			19.5			19.4				
47.9	below French Creek			20.9	**18.2**	**18.7**	19.1	*19.7*	*19.0*	20.3	
48.2	above French Creek			20.8	**19.7**	**18.5**	19.8	*20.9*	*20.0*	20.3	
50.2	at Fay Lane			19.6	**19.2**		20	*19.3*		20.2	19.7
50.2	above Fay Lane (bottom)									19.3	
50.2	above Fay Lane (surface)									20.1	
52.8	Alexander				**17**	**19.9**					
53.2	at Alexander's (bottom)									20.2	
53.2	at Alexander's (surface)									21.0	
53.6	Scott River tailings						20.3				19.8
54.5	at Red Bridge				**18.3**	**17.1**					
54.5	Scott River in tailings									20.4	

High discharge years are in **bold,** low discharge are shown in *italics* .

Table 2.10: Stream MWATs, West Headwaters Sub-Basin, 1996 - 2004

		Maximum Weekly Average Temperature (C)							
LOCATION	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
South Fork at Baker's			**16.3**	**13.8**	17.3	*17.8*	*17.3*	17.4	
South Fork at Blue Jay Creek			**14.8**	**13.5**	15.4	*15.9*	*15.3*	15.9	15.6
Boulder Creek	16								
Fox Creek	14.9								
SF Scott at road 40N21Y								15.8	
Jackson Creek	14.6								

High discharge years are in **bold,** low discharge are shown in *italics* .

Table 2.11: Stream MWATs, East Headwaters Sub-Basin 1998 – 2004

LOCATION	Maximum Weekly Average Temperature (C)						
	1998	1999	2000	2001	2002	2003	2004
E.F at Callahan	**14.4**	**19.4**	21.6	*21.9*	*21.8*	22.1	21.8
Grouse Creek		**16**	18.5				
E.F at Masterson Road	**21**		21.4	*20.9*	*21.7*	22.7	21.5
Kangaroo Creek		**11.6**	12.3				
Rail Creek 1	**16**	**15.1**	17.3	*16.7*	*17.9*	17.7	17.3
Rail Creek 2				*17.0*			
Rail Creek 3			17.4				
Upper East Fork below Houston Creek						17.0	

High discharge years are in **bold,** low discharge are shown in *italics* .

Table 2.12: Stream MWATs, westside tributaries of Scott River, 1996 – 2004

LOCATION	Maximum Weekly Average Temperature (C)					
	1996	1997	1998	1999	2000	2003
Mill Creek - Scott Bar	16.2	16.5	**16.3**	**15.2**	17.1	
Upper Mill Creek					14.2	
Tompkins Creek		16.9	**17.6**			17.6
Tompkins Creek - Potato		17.3				
Middle Creek at Mouth						18.5
Deep Creek Mouth						20.0
Lower Kelsey	16.8	17.4	**16.6**			17.8
Upper Kelsey	10.9					
Lower Canyon		15.4	**15.2**			15.8
Upper Canyon	15.5	15				
Lower Boulder Creek	14.4	14				

High discharge years are in **bold,** low discharge are shown in *italics* .

Table 2.13: Stream MWATs, eastside tributaries of Scott River, 1997 – 2001

LOCATION	Maximum Weekly Average Temperature (C				
	1997	1998	1999	2000	2001
Sissel Gulch			**16.3**	18.6	*16.9*
Moffett Creek	16.9	**16.8**	**15.8**	17.6	*17.5*

High discharge years are in **bold,** low discharge are shown in *italics* .

Table 2.14: Stream MWATs, tributaries of canyon section of the Scott River, 1996 – 2003.

	Maximum Weekly Average Temperature (C)					
LOCATION	**1996**	**1997**	**1998**	**1999**	**2000**	**2003**
Mill Creek - Scott Bar	16.2	16.5	**16.3**	**15.2**	17.1	
Upper Mill Creek					14.2	
Tompkins Creek		16.9	**17.6**			17.6
Tompkins Creek - Potato		17.3				
Middle Creek at Mouth						18.5
Deep Creek Mouth						20.0
Lower Kelsey	16.8	17.4	**16.6**			17.8
Upper Kelsey	10.9					
Lower Canyon		15.4	**15.2**			15.8
Upper Canyon	15.5	15				
Lower Boulder Creek	14.4	14				

High discharge years are in **bold,** low discharge are shown in *italics* .

CHAPTER 3. SEDIMENT

Key Points

- The sediment source analysis addresses both natural and human-caused sources of sediment.
- Road-generated sediment rates calculated from road inventories and modeling in the South Fork subwatershed were applied to other parts of the watershed.
- Granitic bedrock and decomposed granite soils were considered separately in the road-generated sediment estimates.
- Large mass-wasting features were inventoried for the entire watershed from aerial photos.
- Streamside sediment source estimates were based on inventories of stream banks and streamside features contributing sediment in sample reaches.
- Streamside sample reaches were identified using a stratified random sampling approach. The results were then extrapolated to other stream reaches based on geology.
- The largest sediment sources are from streamsides and are the result of multiple interacting human activities.
- Results show current sediment delivery is 167% of natural sediment delivery.
- The TMDL is set at 125% of natural sediment delivery.
- The sediment TMDL for the Scott River watershed is 560 tons of sediment per square mile per year.

This chapter describes the sediment source analysis, study methods, sediment TMDL, sediment load allocations, and margin of safety for the Scott River watershed. Please note that all figures and tables for this chapter are located at the end of the Staff Report.

3.1 STUDY METHODS

3.1.1 Sampling Approach and Rationale

The sediment source inventory and analysis is divided into three components:

- Road-generated sediment as calculated based on modeling (SEDMODL2) and road inventories.
- Large mass-wasting features inventoried on aerial photos.
- Streamside sediment sources as calculated from inventories of stream banks and discrete erosion and mass-wasting features contributing sediment.

Because not all stream reaches can be inventoried, a sample of stream banks was inventoried based on a stratified random sampling approach.

3.1.2 Subwatersheds Used in Compilation

For the purpose of the TMDL analysis, the Scott River watershed was divided into seven subwatersheds, each of which has more continuity of characteristics within it than it has with the other subwatersheds. The sub-watersheds, shown on Figure 3.1, are as follows:

- **West Canyon.** Steep rugged mountains. Mostly sedimentary and metamorphic bedrock with smaller areas of mafics and only a small area of granite. Greatest concentration of landslides in the Scott is in the western portion of this area. Mostly high precipitation except lower slopes of the mountains.

- **East Canyon – Scott Bar Mountains**. Steep rugged mountains, almost all sedimentary and metamorphic bedrock. Only one landslide mapped. Mostly drier than West Canyon except in highest Scott Bar Mountains.

- **Eastside**. Moffett Creek drainage. Steep country, but not as high as mountains that ring the rest of Scott Valley. Mostly sedimentary and metamorphic bedrock with a little mafic bedrock in the mountains and a little Quaternary in the valley bottom. No significant landslides were mapped or observed on aerial reconnaissance. Least precipitation of the seven subwatersheds.

- **East Headwater**. East Fork and Noyes Valley Creek drainages. Steep, rugged mountains, more than half sedimentary and metamorphic bedrock, but has largest area of mafic bedrock and a little granitic bedrock. One upland valley has Quaternary glacial deposits, other Quaternary deposits too small to map at scale shown. Few landslides. High country is intermediate in precipitation between the Westside/West Headwater area and the Eastside.

- **West Headwater - South Fork Drainage**. Steep, rugged mountains. Largely granitic and mafic bedrock, small amount of sedimentary and metamorphic bedrock. High precipitation in the high country and lower precipitation at lower elevations. Has several landslides and several hydraulic mining sites. High precipitation in the high country and lower precipitation at lower elevations.

- **Westside**. Steep, rugged mountains. Mixed bedrock geology but has largest areas of granitic bedrock, which produces unique problems. Landslides widely distributed in the steep country, particularly in granitics, but not great concentrations of landslides. High precipitation in the high country and lower precipitation at lower elevations.

- **Scott Valley and Eastern Valley Side**. Valley bottom is low relief, low precipitation, and underlain by Quaternary alluvium. Eastern valley side has low precipitation like the valley bottom, and much of the drainage does not reach the Scott, so it is a low sediment contribution area.

3.1.3 Combined Geologic Units

The geologic material and structure underlying a particular area is a primary factor in determining not only sediment delivery under natural conditions but also sediment delivery in response to human activities. For this reason staff chose bedrock composition as the factor on which to stratify sampling. The GIS geology coverage used (Saucedo et al., 2000) shows not less than twelve geologic units mapped in the Scott. Because applying all of these units would create too many strata for a practical sampling program, similar mapped units were combined. For the purposes of the streamside sampling program, staff aggregated the mapped units into four geologic units:

- Quaternary Deposits
- Granitic Bedrock
- Mafic and Ultramafic Bedrock
- Sedimentary and Metamorphic Bedrock

3.1.4 Description of Geologic Units

3.1.4.1 Quaternary Deposits

This unit is primarily unconsolidated gravel, sand, and soil that make up the floor of Scott Valley and the lower reaches of some tributary valleys. For the most part this unit forms flat or gently sloping land, as the land surface is the surface on which these materials were deposited. For this reason, the main means of erosion over most of the area of this unit is not slope processes but rather bank erosion of streams and occasional gullying. The primary management-related sediment delivery over most of the unit is associated with crop production, livestock management, and dredging legacy. Small areas within this unit include glacial deposits in the high valleys of the Scott Mountains, and landslide deposits.

3.1.4.2 Granitic Bedrock

This unit is exposed in the mountains paralleling the west side of Scott Valley. The suite of granitic rocks ranges in composition from granite to granodiorite (Mack, 1958, p. 24), and is generally fine grained and weathers to noncohesive and highly erodible soil. In the Klamath Mountains and the Sierra Nevada of California this decomposed granite soil is known as DG, both in the scientific literature and in popular parlance. During weathering of the granitic rock, cohesion between grains is lost, leaving the material as a mass of separate grains ranging in size from fine sand to small pebbles and lacking enough clay to bond it together. Consequently, the DG is highly susceptible to dry ravel, rill and gully erosion, debris slides, and debris torrents (Kellogg, 1992, p. 64). In addition, disturbance of the surface, or an increase in the degree of slope, tends to accelerate these processes. The problems of stability and sediment contribution associated with DG are sufficiently severe, widespread, and costly that a conference dedicated to these problems and their solutions was convened in Redding, California in 1992 (Sommarstrom, 1992).

3.1.4.3 Mafic and Ultramafic Bedrock

This unit is largely serpentine along with minor basalt, peridotite, and gabbro (Jennings, 1977). These rocks occur in parts of the Marble Mountains in the northwest part of the watershed, in the Scott Mountains in the southeast, and in a disconnected belt that runs from the south part of the Scott watershed to the northeast part. Some outcrops are the original igneous rock, but most are partly or wholly altered to serpentine. Much of the area underlain by mafic and ultramafic rocks is steep mountains. The rocks weather to form soil that is finer-grained and more clay-rich than soil formed on granitic rocks. The result is less tendency toward dry ravel, sheetwash, and rillwash. Some limited areas of sheared bedrock are vulnerable to landsliding.

3.1.4.4 Sedimentary and Metamorphic Bedrock

This unit makes up more than half of the area of the Scott River watershed and includes sedimentary rocks of many lithologies, mostly of Mesozoic age; metamorphic rocks of low to medium grade including amphibolite, greenschist, blueschist, and metavolcanics; and some Tertiary metavolcanics (Wagner and Saucedo, 1987). Although these suites of sedimentary and metamorphic rocks vary in geomorphic expression and potential for sediment contribution, in general they have more in common among themselves in terms of soils formed, structural strength, and slope stability than either suite has with the granitic or mafic rocks. For that reason the sedimentary and metamorphic rocks form a natural grouping in the context of this study.

3.1.4.5 Extent of Geologic Units

Table 3.1 summarizes the areal extent of geologic units in the Scott River watershed. The GIS geology coverage (Figure 3.2) has proved satisfactory for the job at hand. Field observations in October and November of 2003 and May-July of 2004 at computer-generated random stream sample locations showed no significant differences between geologic units shown on the GIS coverage and geologic units observed on the ground.

Table 3.2 summarizes the distribution of the geologic units in the seven subwatersheds used in this analysis. Granitic rocks, which are a major sediment contributor, especially when disturbed, underlie twenty-eight percent of the Westside subwatershed, forty-eight percent of the West Headwater subwatershed, and lesser amounts of the West Canyon and East Headwater subwatersheds. The East Canyon and Eastside subwatersheds are underlain mostly by sedimentary and metamorphic rocks. The highest proportion of mafic and ultramafic rocks occur in the East Headwater subwatershed where they underlie forty-three percent of the area. The Scott Valley subwatershed contains most of the Quaternary deposits in the Scott, as they cover most of the valley floor, but this subwatershed also is underlain by a substantial area of sedimentary and metamorphic rocks, primarily on the east side of the valley and in the hills at the north end of the valley. A discontinuous belt of mafic and ultramafic rocks trends northward from the Callahan area along the base of the mountains on the east side of the valley.

3.1.5 The Role of DG Soils

A significant portion of the Scott River watershed, 10.6 percent of the area (derived from Table 3.2), is underlain by granitic bedrock. The soils that form on this suite of rocks are widely recognized as some of the most erosive soils anywhere. This susceptibility to erosion not only applies to natural conditions but produces greatly accelerated and persistent erosion when the soil is disturbed, especially on steep slopes (Sommarstrom et al., 1990; USSCS, 1991; Sommarstrom, 1992).

The Granitic Sediment Study (GSS) of Sommarstrom and others (1990) is an evaluation of the role of DG soils in the Scott River watershed, and an estimate of the sediment contribution of DG in the watershed. The authors estimated the amount of sediment mobilized by different processes in different settings: sheetwash and rill erosion, road cuts, road fills, road surfaces, skid trails, streambanks, and landslides. They did not include a category defining soil creep, and staff interpret that they included soil creep processes in this highly granular soil in the sheetwash and rill erosion category. That study centered on contribution to the mainstem Scott River and recognized that much of the sediment mobilized is not transported immediately to the Scott but is stored on hillslopes and in swales, streambanks, and the channel bedload of tributaries.

In the GSS (Figure 2-11, p. 2-44), the authors estimated for each process the amount of sediment mobilized and the amount delivered to the Scott River. The proportion delivered ranges from five percent for sheetwash and rill erosion to 35 percent for stream bank erosion. For all processes combined, they estimated that 79 percent of mobilized sediment goes into storage and 21 percent is delivered to the Scott River. The GSS applied a different approach than the TMDL study, but the results can be compared in important ways.

The TMDL study is concerned not only with the Scott River, but also with the tributaries as they provide spawning and rearing areas for salmonids. Also, the TMDL study is less concerned with upslope processes and how much sediment is mobilized than with the interface between mountainside and stream system and how much sediment actually crosses into the stream system, including tributaries.

To assure uniformity of methods on all areas, staff applied the same system of field observations and data compilation to the DG areas as to the areas of other bedrock units. These results are presented first in the summary section.

However, DG produces sediment through a significantly different balance of processes than the other bedrock units. For example, roadcuts in DG are a dominant generator of sediment (Sommarstrom et al., 1990, p. 2-32), in contrast with other units. Also, DG is particularly susceptible to disturbance, and disturbed areas are slow to heal. For these reasons, staff did a separate calculation of the sediment estimate using the DG sediment contribution rates estimated in the GSS for areas of Granitic Bedrock, and rates from the TMDL study for the other bedrock units. These calculations are discussed in the individual inventory sections and are summarized in separate summary tables.

3.1.6 Effects of Multiple Interacting Human Activities (EMIHAs)

In published literature on forest management and surficial processes (e.g. Reid, 2001; Dunne et al., 2001), the term cumulative watershed effects is used to designate long-term cumulative and/or synergistic effects from multiple episodes of human activities. In addition, the term cumulative impacts is used in legal documents with its own specific meaning under the California Environmental Quality Act (CEQA) (Pub. Resources Code section 21000 et seq.). In order to avoid confusion or ambiguity, this TMDL document does not use the term cumulative effects and instead uses the term Effects of Multiple Interacting Human Activities (EMIHAs). In the following discussion, the published literature on cumulative watershed effects is referenced. Although this discussion is introduced in the Sediment TMDL chapter, the effects discussed may also affect other properties of a water body, including temperature conditions.

EMIHAs are changes in a watershed that affect processes in the watershed and are influenced by multiple human activities in the watershed. The multiple activities may be simultaneous or at different times, but they exert multiple influences on the processes in the watershed (Coats and Miller, 1981; Reid, 1993, 2001). Many EMIHAs are incremental and synergistic effects of multiple controlling factors, and the very fact of interaction creates difficulty in ascribing the cause of a particular effect to a specific action. One key concept is that the effects may not be concentrated at their point of origin and they may not be immediate.

EMIHAs take many forms. Reid (1993) discusses:

- Changes in hydrology including water input, runoff generation, water transport on hillslopes, water transport in channels, and water budgets.
- Changes in sediment generation and transport including erosion and sediment transport on hillslopes, gullies, and landslides; sediment delivery to streams; erosion, transport, and deposition in channels.
- Environmental change in organic material including changes in streamside vegetation, in-channel production of organic material, and in-channel transport of organic material.

Impacts of EMIHAs take many forms, a few of which are noted here:

- Impacts on fisheries due to changes including flow characteristics and channel morphology, water temperature, food availability, predation, and grain-size of the stream bed, combinations of which affect spawning and rearing success. These affect the commercial fishery as well as sport fishing.
- Water quality for agricultural, domestic, recreational, or industrial use.
- Other beneficial uses that are enumerated in Section 2.2.1.

A system to analyze and predict EMIHAs was developed by The University of California Committee on Cumulative Watershed Effects (Dunne et al., 2001). That report advocates a watershed approach that ideally would involve stakeholders in the watershed and time and resources to do modeling of many factors in the watershed and carry through to changes in policy and operations within a watershed. This TMDL study lacks the resources to apply such a broad approach, but neither can it ignore the presence and impacts of EMIHAs. What follows is a brief description of EMIHAs in the Scott River watershed and the Regional Water Board staff's approach to them. The methodologies used for identifying streamside sediment delivery features attributing sediment delivery to EMIHAs are discussed in more detail in Section 3.4.3.

3.1.7 Sources of Information

Information for this Sediment TMDL comes from a variety of sources. The Siskiyou Resource Conservation District (RCD) contributed information on environmental and habitat conditions and made their library of published reports and consultant reports available.

Timber Products Corporation and Fruit Growers Supply Company have allowed use of road inventory data in the South Fork Scott River watershed and permitted access to timberlands in that watershed. Resource Management, a consulting company in Fort Jones, analyzed road inventory data supplied by timber companies and the United States Forest Service (USFS). Regional Water Board staff field checked random samples of the road inventory data. VESTRA Resources produced the landslide inventory using an aerial photo survey.

Regional Water Board staff researched sediment contributions and trends using field studies, reports from other government agencies, consulting reports, and published literature. The USFS contributed data on road inventories and landslides and consultation on conditions in the watershed.

A Technical Advisory Group (TAG) consisting of stakeholders and representatives of other government agencies met at intervals with Regional Water Board staff to provide evaluation and guidance in the research and preparation of the TMDL. Dr. Sari Sommarstrom, also a member of the TAG, contributed her considerable expertise and local knowledge and access to her library.

California Department of Forestry and Fire Protection coordinated the road inventory and associated GIS work of Resource Management. Published scientific literature was used extensively and is referenced in this document.

3.1.8 South Fork Pilot Study

The South Fork Pilot Study was conducted in the South Fork Scott River (South Fork) as a demonstration project to illustrate the methods used in preparing a sediment TMDL with respect to gathering data and estimating sediment contribution to the stream system. The study was done at the request of Fruit Growers Supply, Inc. and Timber Products Company (the Companies) with the understanding that should the Companies find the methods to be appropriate and satisfactory they would grant access to Regional Water Board staff to gather specified data on other company lands throughout the Scott River watershed and would supply road inventory data for the companies' holdings in other parts of the Scott River Watershed to Regional Water Board staff. The Companies granted Regional Water Board personnel access to gather data along streams on company properties in the South Fork watershed. A Fruit Growers forester accompanied Regional Water Board staff in the field to observe sampling methods and field practice.

In addition, the Companies made their road inventory data in the South Fork watershed available to a third party, Resource Management Inc. (RM), for the purpose of calculating summaries and performing analyses of the data on behalf of Regional Water Board and the California Department of Forestry and Fire Protection (CDF). These data were used to estimate road surface erosion using SEDMODL2 (NCASI 2003) and provide summaries of other road-related sediment delivery sources in the South Fork. Under this agreement Regional Water Board staff did not take possession of the road inventory data. Regional Water Board staff field checked road-associated point sources of sediment in the company of RM staff.

After review of the South Fork Pilot Study, the Companies did not feel sufficiently confident in the process used in the Study, and declined to provide access to other company lands or associated data. Given time constraints in the TMDL consent decree schedule, Regional Water Board staff were not able to pursue resolution of the outstanding issues in the context of the South Fork Pilot Study. Instead, the road inventory data for the South Fork Pilot Study was used to calculate rates of sediment delivery per road mile in each geologic unit, and these rates were applied to other roads in the watershed. This process is discussed in Section 3.2.

3.2 ROAD RELATED SEDIMENT DELIVERY

3.2.1 Two Estimates Made

Road-related sediment was estimated in two ways. The first estimate treats roads on all geologic units in the same way. RM applied a computer model, SEDMODL2, to estimate contributions from road tread and cutslope on roads in the South Fork (West Headwaters) watershed in all four geologic units. As part of this process, RM applied information from road inventories on private land in the South Fork watershed to estimate contributions from road-related discrete features in that subwatershed. The inventories were conducted on about 5.5 square miles in the South Fork. Regional Water Board staff field checked many of these features as part of the South Fork Pilot Study (NCRWQCB, 2005b) to verify volume and to estimate age in order to estimate rate of contribution. Because this type of road inventory was not available in other subwatersheds, the rates estimated in the South Fork were applied to the rest of the subwatersheds in the Scott River watershed. Assumptions used in this application are:

- Distribution of road surface types (paved, unpaved) is similar
- Distribution of travel intensities on roads is similar
- Precipitation and storm intensity are similar
- Distribution of vegetative cover alongside roads is similar.

Variations occur in all of these factors, but in the context of the estimate many of the variations are opposite in effect. For example parts of the Westside Subbasin have more precipitation than the South Fork, which may deliver more sediment per road mile, but the Eastside Subbasin has less precipitation, and thus less runoff. The assumptions were based on the best information available.

Thus, the basic assumption is that the amount of sediment produced per mile of road in the geologic types in the South Fork subwatershed is the same as the amount of sediment produced per mile of road in those same units in the other subwatersheds. The assumption is made that road conditions on private land in the South Fork can be used to represent conditions along similar roads in the same geologic units in the other subwatersheds. Regional Water Board staff believe this is a reasonable assumption, based on observations of road construction and conditions in other subwatersheds.

The second estimate applies SEDMODL2 to roads in all geologic units except Granitic bedrock. For roads on granitic bedrock the sediment delivery rates applied are derived from the GSS in the Scott River watershed. The GSS found significantly higher DG sediment delivery from both anthropogenic and natural causes than did SEDMODL2. Sediment delivery from road-associated discrete sediment sources on granitic bedrock was treated as in the second estimate. All other geologic units were treated as in the first estimate.

In the four subwatersheds that include areas of granitic bedrock the difference between the first and second estimates of the sediment delivery processes from roads considered in SEDMODL2 range from nine percent to fifty-nine percent greater using the second estimate. The differences are approximately proportional to the proportion of the subwatersheds that is underlain by granite. Nonetheless, the estimate of total delivery of sediment from roads is relatively small in the big picture.

Because sediment generated on roads is not all delivered immediately to a stream, the distance of a road from a stream is a factor to consider in estimating sediment delivery. Both models include calculations based on the distance of roads from a stream. Table 3.3 presents the lengths of roads of different types and their distances from a stream through the whole of the Scott River watershed. For a more detailed comparison, Table 3.4 shows the same data divided out by subwatershed. These tables also include numbers of stream crossings, road miles, and road densities.

3.2.2 Discrete Sediment Sources (Road Inventory and Field-Check)

Inventories of discrete sources of sediment along roads are not presently available for most of the Scott River watershed. However, staff had access to an inventory of road-related erosion and sediment delivery completed by Resource Management (RM) in 2000 on all timber company roads in the South Fork subwatershed. That survey documented road-associated discrete sources of sediment including road-stream crossings, crossing failures, fill and cutbank failures, and gullies, along with the volume of each discrete sediment source. The purpose of the inventory was related to road maintenance, for which the age of features was not needed so age was not estimated. For that reason, and to evaluate the inventory, Regional Water Board staff, accompanied by RM staff, visited individual sites to verify volume and estimate age. The method is detailed in the South Fork Pilot Study (NCRWQCB, 2005b) and summarized below.

The RM road survey documented erosion at sixty-nine discrete features. Regional Water Board staff and RM personnel visited thirty of those features in 2004 and estimated age of erosion where possible. The remaining thirty-nine features were not visited, some because they had been repaired and some because time and resources did not permit total coverage. Of the thirty features visited, nine had been modified by repairs so that the age could not be estimated; staff estimated the age of the remaining twenty-one.

Of those twenty-one features, sixteen have estimated ages of less than fifteen years. Most of these are estimated to be within the 5-10 year age category. A major rain-on-snow event occurred in 1997, seven years before the field inspection, and, on the basis of anecdotal evidence and field estimates, staff attribute the major part of the erosion or failure of these features to that storm. The US Forest Service estimated runoff of the 1997 event in the Scott River to be equivalent to a 14-year recurrence interval event (de la Fuente and Elder, 1998, p. 10), and that event apparently caused more erosion than any other storm during the last 15 years. A flood risk evaluation in the area of Callahan prepared for the Siskiyou County Department of Public Works (Norman Braithwaite Incorporated, 1999) estimated a 30-year recurrence interval for the 1997 flood in that area. Staff chose to use the fourteen-year recurrence interval in our estimates.

Because the recurrence interval of this significant storm event brackets the age categories of a majority of the sites whose age staff could estimate, staff chose to isolate that time interval for the estimate of the rate of sediment contribution. The calculations of sediment input in the South Fork watershed in Section 3.1.8 are based on the volume of measured features divided by fourteen.

The estimated rate of sediment delivered from road-associated large and small features in the South Fork (exclusive of the anomalous features described below) was extrapolated to the other subwatersheds on the basis of road type and geologic units. This extrapolation is based on the assumption that similar road types, on similar substrate, at similar distances from the streams, will deliver similar amounts of sediment. While these assumptions surely vary in accuracy over different areas, staff believe, on the basis of field studies in many areas in the Scott, that conditions in different parts of the watershed have sufficient commonality to group in this way for the purpose of the watershed-wide TMDL study. Any land management decisions made in the future should be based on more detailed studies of the areas in question.

RM estimated the number of stream crossings using SEDMODL2. Water Board staff conducted a GIS exercise to estimate the number of stream crossings. RM and Water Board staff were within 97% agreement in the respective estimates. For that reason, the number of stream crossings estimated by RM were accepted.

In the RM South Fork road survey, the largest contributing features were all located within a single quarter-mile-long section of failing road. These few features accounted for seventy-five percent of the total contribution from road failures. Thus, these features are anomalous in context. For that reason they were not included in the group that was used to calculate the rates used to extrapolate to the South Fork watershed but instead were combined and treated separately as a single discrete feature added to the South Fork sub-watershed sediment summary.

Outside the South Fork, such anomalous features pose a problem in estimating sediment delivery. At present we cannot determine how many such features may have been unaccounted for in the other sub-watersheds, although some are large enough that VESTRA found and included them in the aerial photo landslide survey (Section 3.3). However, staff may have slightly underestimated anthropogenic sediment contributions because some anomalous features that were not large enough to be found on the landslide analysis may have not been counted.

The road dataset used was that developed for this project by VESTRA Resources, the contractor that performed the aerial photo analysis described in Section 3.3. During the field inventory, RM identified a few additional roads and added them to the dataset.

3.2.3 Granitic Substrate and Road-Associated Sediment – The DG Factor

The computer model used (SEDMODL2) takes into account road class, traffic volume, and a geologic erosion factor that is a multiplier to account for different rates of erosion on different substrates. However, the model does not specifically take into account the particularly high sediment contribution of the DG in the Scott River watershed and the tendency for elevated erosion rates to continue following disturbance.

Megahan (1992, p. 18), citing studies primarily in the Idaho Batholith, which has granitic rocks with weathering characteristics similar to those in the Scott, found that the highest erosion rates on cut banks occurred in the first two years. During this time rates decreased rapidly as the cut surfaces seasoned and litter and vegetation came to cover parts of them. After two years rates stabilized. Nonetheless, Megahan (1992, p. 18, 21) found that, “Erosion rates at this time were still accelerated, averaging about 50 times greater than undisturbed.”

Megahan (1992, p. 24) noted that, “While some road builders advocate constructing vertical cuts in granitic terrain, the data reveals that if you build them steeper, they are going to erode faster. Granitic road cuts will eventually end up at the natural angle of repose; it depends whether you want it now or later.”

The GSS in the Scott (Sommarstrom et al., 1990, p.5-3) also estimated that most of the road-associated sediment production was from cut banks. That study reached two conclusions that staff must consider in estimates for the TMDL:

- Average annual erosion for the entire road prism in granitic areas was 737 tons per mile, or 149 tons per acre of road prism. In the road prism the GSS includes cut slope, ditch, and fill slope as well as road surface. Erosion from the road surface alone averaged 11 tons per acre. The GSS cites these values (p. 2-31) as falling within the range reported by others on sandy loam soils.
- Sixty-four percent of road-associated erosion was found to come from the cut bank, which was the highest category of soil loss from all sources and made up 40 percent of the total.

Based on the GSS, the thickness of road surface eroded annually in the granitic area is calculated as follows:

1 acre = 43,560 sq ft.
11 tons / acre = 22,000 pounds per 43,560 sq ft
43,560 sq ft / 22,000 lb = 2 lb per sq ft. per year.
1 cu ft of sediment weighs 100 lb
2 lb per sq ft /100 lb per cubic ft = .02 ft thickness per year = .24 inch per year.

Most of the roads in the Scott were constructed before 1970, 35 years ago. Assuming they were all built in 1970, then:

35 yr x .24 inch = 8.4 inches of road surface lowering in 35 years. This rate of road surface erosion is significant, but considering the occasional resurfacing of eroded and failed parts of the road surface, it is reasonable.

To account for differences in erosivity of substrate, SEDMODL2 uses a multiplier that ranges from one for the least erosive rocks to five for the most erosive. In other words the model assumes that the most erosive rocks are on the order of five times as erosive as the least erosive rocks. Megahan (1992), Sommarstrom and others (1990) and others cited by these authors, as well as our field observations, suggest that the multiplier of five is substantially too low. Even with the model assuming no cover at all, SEDMODL2 estimated that only 23 percent of road-associated sediment generated on granite substrate comes from the cut bank.

The GSS was based on field studies and observations along many miles of road, and staff judged that its results must be considered within the area of DG soils. Accordingly, staff did a second estimate of road sediment contribution, applying the GSS rate of erosion in DG areas.

The GSS (Sommarstrom et al., 1990, Fig. 2-11) classified road-related sources into the categories of road cuts, road fills, and road surface. Taken together, these sources yielded an estimated 212,196 tons/year in their study area. Of that amount, an estimated 40,242 tons (19%) was delivered to the Scott River. The remainder went into storage in hillslope swales, hillslopes, channel margins, upper banks, alluvial fans, and channel bedload in tributaries.

The GSS approach is different from the TMDL approach in that the GSS authors were evaluating delivery to the mainstem Scott River, while the TMDL is evaluating delivery to the stream system as a whole, including tributaries. For that reason, the TMDL study cannot exclude the sediment that goes into storage in the channel bedload of tributaries.

3.2.4 Estimates of Road-Related Sediment Contribution

SEDMODL2 is a computer model developed to estimate the delivery of sediment to streams from roads using as parameters road width and type of surface, slope, geologic substrate, road use pattern, and distance of each road segment from a stream.

The creator of SEDMODL2, the National Center for Air and Stream Improvement (NCASI, 2004; and website accessed 4/4/05) describes SEDMODL2 as follows:

> …a GIS-based road erosion and delivery model designed to identify road segments with high potential for delivering sediment to streams. The model uses an elevation grid combined with road and stream information layers to produce what is essentially a computer-generated version of the Washington surface road erosion model. It estimates background sediment and generation of sediment for individual road segments, finds road/stream intersections, and estimates delivery of road sediment to streams.

SEDMODL2 was used to estimate contributions from road surfaces, cutbanks, and background. SEDMODL2 defines background as the contribution of sediment delivered to streams by soil creep. The soil creep contribution is included in Section 3.4 of this report.

For the stream network part of the model, RM first applied the GIS stream dataset from USGS 1:24,000 scale topographic maps. However, the stream network as observed on the ground during the inventories proved to be considerably denser than the USGS dataset. That is, a significant number of road/stream crossings were found where the stream dataset did not indicate a stream. RM then applied the Klamath National Forest (KNF) GIS stream network, as it is significantly denser, although it too was found to be under-dense relative to field observations. In some places RM field personnel found streams that were not shown even on the KNF coverage. In those cases, RM used a ten-meter digital elevation model to generate the stream course, and the stream feature was cut off just above the highest road/stream crossing identified in the watershed.

Tables 3.3 and 3.4 summarize parameters that go into the calculations of road-related sediment delivery in the Scott River watershed.

Table 3.3 shows the number of road-stream crossings and the miles of paved and unpaved roads at different distances from streams in the Scott River watershed. In SEDMODL2 the term direct delivery means that sediment from a road, once mobilized, is delivered directly to a stream; this happens primarily where the road surface, fill slope, and cut slope all meet at a stream crossing. Under all other conditions, fill slopes are assumed to not deliver sediment. For situations other than direct delivery, SEDMODL2 calculates percent sediment delivery from a road on the basis of distance from a stream. Distance categories are 0-100 feet, 100-200 feet, and greater than 200 feet from a stream.

Table 3.4 summarizes the number of road-stream crossings and miles of road at different distances from a stream sorted by geologic unit in each subwatershed. The information in this table serves as the basis for calculation of sediment contribution using SEDMODL2.

The next three tables (3.5, 3.6, and 3.7) develop the estimate of road-associated sediment.

Table 3.5 is in two sections. The upper section shows the estimated road-related sediment delivery rates in tons/road mi-yr from the South Fork Pilot Study (b 2005a) from roads on all geologic units. The South Fork is the area where the most detailed information was available. This table includes estimates of delivery from discrete features in the RM South Fork road survey and SEDMODL2 estimates of road tread and cut slope delivery. The lower section of the table is a separate estimate of road-associated sediment from granitic terrane derived from the GSS through the following procedure: The GSS estimate of total road-associated sediment generated was divided by the number of miles of road in the Granitic study area to derive an average rate of sediment mobilized in tons/road mile-yr. The proportion of mobilized sediment that is delivered to a stream is estimated by applying the delivery rates used in SEDMODL2 for direct delivery and delivery from distances from a stream of 0-100, 100-200, >200 feet.

The road survey-SEDMODL2 estimate and the GSS estimate use different categories to some extent, but the point to note is that delivery from cut banks is much greater in the GSS estimate. The rates for both estimates are carried forward to Table 3.6.

Table 3.6, in three sections, shows the estimated rates of road-associated sediment delivery in the Scott River watershed based on the rates estimated in the South Fork in Table 3.5. The upper section of Table 3.6 applies the estimated sediment delivery rates in the South Fork based on SEDMODL2 and the RM road survey (upper section of Table 3.5) to roads on all geologic units in the Scott River watershed. The middle section of Table 3.6 applies sediment delivery rate estimates on Granitic substrate in the South Fork from the GSS (middle section of Table 3.5). As seen in the right hand column in Table 3.6, the estimated sediment delivery from Granitic substrate using the GSS is about twice the tons/sq mi-year as what was estimated using SEDMODL2 and the road survey. Much of the increase comes from cut slopes.

Table 3.7, in five sections, shows the road-related sediment estimates broken out by geologic unit within each subwatershed. The upper section of the table shows estimates for Quaternary, Mafic, and Sedimentary/Metamorphic substrates. The Granitic contribution from the SEDMODL2-road survey estimate is summarized separately in the middle section for easy comparison with the GSS influenced estimate in the bottom section. In each subwatershed that has granitic rocks, the estimate that takes the GSS into account is a bit greater than twice the estimate that does not. The bottom section summarizes the road-associated sediment estimates. Despite a significant difference in estimated rates from Granitic substrate (Table 3.8), the difference in road-related sediment delivery rate from all units combined is increased only from 11 to 14 tons/sq mi-yr (Table 3.7), a 27% increase. The large difference in the estimates of Granitic contribution is minimized by the small percentage of the Scott River watershed underlain by granite and the large percentage underlain by Sedimentary/Metamorphic rocks, which have a relatively low contribution (Table 3.1).

3.3 AERIAL PHOTO LANDSLIDE SURVEY

Sediment delivery from landslides was estimated using photo interpretation from stereo aerial photos taken several years apart. Changes in presence or size and configuration of landslides between the photo sets were analyzed, and a proportion of the interpreted features were field checked to estimate volume and age. Additional information was used from USFS photo inventories that used 1992 and 1997 aerial photos. Four subwatersheds have significant sediment delivery from landslides: The West Canyon subwatershed delivers about 250 tons/sq mi-yr and the East Canyon, Westside, and West Headwater subwatersheds deliver in the range of 15-20 tons-sq mi-yr.

3.3.1 Methods

Landslides in the Scott River watershed were inventoried by VESTRA Resources using stereo aerial photos and compiled in ArcView GIS. VESTRA evaluated available photo coverages to obtain a baseline to evaluate changes in landslides through time. In this TMDL study the last 20 years are of most interest to use as a basis in understanding what processes are active at present.

No single set of existing aerial photographs covers the entire Scott River watershed, and private land and Forest Service land are photographed at different times and as separate projects. On both private and Forest Service land staff selected two coverages on the basis that (a) each coverage includes a large portion of the Scott River watershed, (b) they are recent, and (c) they are separated by an interval appropriate to the time scale of the study. The four coverages chosen (Figure 3.3) include three different types of photography and four different scales.

With these photo sets, 88.3 percent of the Scott watershed has coverage at two times, 8.1 percent has coverage at one time, and only 3.6 percent of the area is not covered. The areas of single coverage and no coverage are in the lower mountains in the Kidder Creek-Shackleford Creek area (Figure 3.3), an area where landslides are not a significant factor. The areas of most abundant landslides – West Canyon, Westside, and West Headwater subwatersheds – have excellent coverage with the Forest Service photos.

Results were compiled on digital ortho quarter-quads (DOQQs) based on 1993 aerial photography. Landslide features were identified and attributed using the following procedures.

3.3.2 VESTRA Aerial Photo Interpretation

Stereo pairs of the 1999 photos were examined under a mirror stereoscope for evidence of active or recent landslides. Features interpreted as possible landslides were marked as polygons, lines, or points, according to the following criteria:

- <u>Polygon</u> – Non-linear landslide feature larger than 1 acre.
- <u>Line</u> – Linear landslide feature – most are debris torrent scars in steep channels.

- Point – Landslide feature less than 1 acre in size. Pilot work indicated that features smaller than 1 acre cannot be consistently and repeatably identified and delineated; however, it is important to note their presence and density.

Landslide features were identified and marked on the newer photographs, then the location of each feature was reviewed on the older photos to determine whether it was present and if its boundary was different. If the boundary of a feature has changed, appropriate delineations were made on the newer photo record to modify polygons or line segments. The older photos were also reviewed for the presence of landslide features that may not be apparent on the newer photos.

Each landslide feature was attributed with codes representing status of vegetation in each set of photos, intersection with an anthropogenic feature, landslide type, and hydrologic connectivity. Presented in the following sections is a summary of results of this analysis.

Using the 1993 DOQQs as a base, polygons, points, and lines were digitized in a GIS coverage and attributed with their codes. As part of the South Fork Pilot Study, Regional Water Board staff and VESTRA staff were able to field check the photointerpretation on all sites but one in the South Fork (b 2005a). In the remainder of the Scott River watershed, approximately 15 percent of photointerpreted sites were field checked.

3.3.3 Estimation of Sediment Delivery Rates

In the aerial photo survey VESTRA assigned a causal effect based on categories of Harvest, Roads, Roads and Harvest, Fire, and Natural. Mining was not assigned a category but is noted in some comments. Staff estimated sediment delivery based on the VESTRA photo-interpreted slide features and the field verification as completed by VESTRA and Regional Water Board staff.

3.3.4 Volume Estimate of Slide Features

The volume of slide features and the rate of sediment contribution were estimated using a combination of photointerpretation, field observations, and extrapolation. It was not possible to investigate in the field every slide feature interpreted from the photos. Accordingly, a sampling of the photointerpreted features, which came to 26 percent, was visited in the field. The area and depth of each were measured or estimated in the field so that volume could be calculated. In addition, the age of each feature was estimated. The combination of depth and area allow calculation of volume, and the age estimate allows estimation of rate of mobilization of sediment.

3.3.4.1 Polygon Features

The area of polygon landslide features was estimated through digitizing on the DOQQs, and then a sampling of features was measured or closely estimated in the field. The average surface area of the polygon features measured in the field was 50 percent of the average as estimated in the digitized photointerpretation. The average of 50 percent was applied to the area of all polygon features in the photo survey. Average depth of the 10 polygon features measured in the field was 7 feet. This 7-foot average depth was applied to all polygon features in the photo survey.

3.3.4.2 Line Features

Line features were assigned no depth or width in the photointerpretation. Of line features surveyed in the field, the average depth was 4 feet, and the average width was 16 feet. The average length of the line features measured in the field was 42 percent of the average estimated in the photointerpretation. These average depth, width, and length percentages were applied in estimating volume of all linear features in the photo survey.

3.3.4.3 Point Features

Points were assigned no dimensions in the photointerpretation. The average estimated delivery from point features examined in the field was 25 tons/year. This contribution rate was applied to all point features in the photo survey.

3.3.5 Initial Estimate of Connectivity and Age

3.3.5.1 Connectivity

Using photointerpretation, VESTRA estimated whether or not each feature was hydrologically connected. When VESTRA field-checked the features, they evaluated the connectivity of each feature. Of the features they estimated to be fully connected, they found in the field that 68 percent were fully connected, 11 percent were partially connected, and 21 percent were not connected. Of the features they photointerpreted to be partially connected, they found 13 percent to be fully connected, 33 percent to be partially connected, and 54 percent not connected. Of the features they photointerpreted to be not connected, they found in the field that 70 percent were not connected, 20 percent were partially connected, and 10 percent were fully connected. These percentages were applied in estimating connectivity and rates of sediment contribution from photointerpreted landslide features (Table 3.9).

3.3.5.2 Age

VESTRA made field estimates of the age of features visited. Of these features, 72 percent were estimated to be approximately 18 years in age. The remaining 28 percent were estimated to be 30 years in age. Age was not estimated for the features that were identified only through the photo-interpretation process. Staff applied the age estimate percentages established in the field to the estimation of sediment delivery rates for all features that are calculated in section 3.6.

3.3.6 U.S. Forest Service Landslide Inventory

The U.S. Forest Service has done two aerial photo inventories of landslides on Forest Service land in the Scott River watershed. The first was done in 1992 using photos from earlier years, and the second was done in 1997 with new photos following the rain-on-snow flood event in the winter of 1996-1997.

3.3.6.1 1992 U.S. Forest Service Photo Inventory

The 1992 inventory in the Scott was part of a more widespread project on Forest Service land, using photos of several scales. Photos used ranged in date from 1971 to 1988 and covered all USFS holdings in the Scott. Flight lines and photo coverage spilled onto a small amount of surrounding properties, and the landslide inventory included all areas that had stereo coverage, including the small spillover to private land. In this survey 305 features were identified in the Scott River watershed. These features fall in four subwatersheds; Westside, West Canyon, West Headwater and East Canyon.

3.3.6.2 1997 U.S. Forest Service Photo Inventory

Following the 1997 storm event, a new set of color infrared photos at 1:40,000 scale was flown to evaluate resulting landslides and other changes in the Klamath National Forest, which includes Forest Service land in the Scott. On these photos, 192 features were identified in the Scott River watershed. Don Elder of the USFS reported that most of these appeared to be new rather than reactivated older features (Coates, 2006). Seventy four percent of the landslide features identified were field checked and dimensions measured. Associations were determined and delivery amounts estimated at the same time. Using a regression analysis derived from field checking more than 800 sampled slide features throughout Klamath National Forest, an area-volume relationship was determined and applied to the 26 percent of the features that were not visited in the field. Their size and association or non-association with human activity were estimated through the photo-interpretation process.

These 192 identified slide features fall in three subwatersheds; Westside, West Canyon, and East Canyon. Of the 192 features, USFS estimated that 52 features were natural, 57 were road-related, 2 were related to either harvest or fire greater than 20 years of age, and 81 were related to a harvest or fire within the last 20 years. The last two categories, classified without distinction between harvest and fire, are ambiguous as to whether human activity was involved in a given case, and for that reason they are of limited use in the TMDL study.

The USFS arrived at volumes mobilized and volumes delivered through field visits and the application of GIS estimation. The USFS estimated delivery percent for each feature and went on to estimate amount of sediment delivered. Sixteen of the slide features were estimated to have no delivery; for the remaining 177 features the estimated delivery values varied from 5 percent to 100 percent.

3.3.6.3 Discussion of USFS Landslide Inventory

Age of features was not estimated, except that those captured after the 1997 flood were directly related to the 1997 event. These features should be treated as discrete features in time and evaluated with that in mind. However, without further field work there is no way to quantify the continuing contribution from these features. Further study is required to evaluate their contribution to the system.

In comparing VESTRA and USFS inventories, staff noted that of the total 498 features mapped in the two USFS inventories, 250 do not appear to have a corresponding feature in the VESTRA GIS layer. Of the 192 features mapped in 1997 with volumes and associations, 79 do not appear to have a corresponding feature in the VESTRA GIS layer. One reason for this apparent discrepancy appears to be that the USFS was mapping many small features that VESTRA did not include in their inventory.

Of the 250 features in the USFS GIS layer that have no corresponding features in the VESTRA study, 78 are less than 0.5 acres, and 52 are between 0.5 and 1 acre in size. Thus 130 (52 percent), of these features are smaller than the one-acre size that VESTRA considered a minimum for repeatable estimation in their survey. Fifty-two (21 percent) of the USFS features are between one and two acres. Field-checked sites were on average 50 percent of the GIS size estimation. Applying a correction factor of .50 yields a figure of 182 features less than one acre out of the 250 features identified in the USFS inventory that did not appear in the VESTRA survey.

In summary, the USFS inventories picked out many landslides smaller than one acre that were not counted in the VESTRA inventory. In this investigation, landslide features less than one acre were accounted for in the streamside sediment surveys, described in Section 3.4.2. Problems in trying to apply this USFS inventory to the TMDL study arise because anthropogenic and non-anthropogenic features are not adequately distinguished, and lack of age estimates precludes estimating average delivery rates. Therefore, the USFS landslide inventory was not used to quantify landslide contributions.

3.3.7 Estimate of Sediment Delivery Rate

Delivery rate was estimated for the features examined by VESTRA in the field using calculations based on the percentages estimated through photo-interpretation and associated field work. These rates were then applied to all the features that were photo-interpreted but not field checked. The general equation is:

Delivery = (Connectivity Value) x (Volume-Size factor) x (Age factor)

Table 3.9 is in two parts. The first part summarizes the numbers of slide features that are interpreted as delivering sediment. The first section shows results of field checking of 97 photo-interpreted landslide features. Field observation showed that 26 percent of these features are delivering sediment. The second part summarizes numbers of features that were not field checked and interpretation of hydrologic connectivity. Of 265 features, 151 (57 percent) are interpreted as partially or fully hydrologically connected.

Table 3.10 is in two parts. The first part summarizes estimates of sediment delivery from photo-interpreted landslide features that are associated with human activity. The second part summarizes estimates of sediment delivery from photo-interpreted landslide features that are not associated with human activity. The left columns in both parts show estimated tons/yr of sediment delivered from field-verified features. The right hand columns show estimated tons/yr delivered from features that have not been verified. Some sediment is counted as delivered from features that were photo-interpreted as not hydrologically connected. The reason for this goes back to the field-checked features, some of which were photo-interpreted as not hydrologically connected but were found in the field to be connected and delivering. This estimation is discussed in the section on Connectivity above. The estimates show a total of 66 tons/yr of sediment delivered from landslides of which 26 tons (39 percent) is attributed to human causes.

3.3.8 Summary of VESTRA Landslide Inventory

This survey shows that landslides are not a dominant source of sediment in the streams in most of the Scott River watershed. Table 3.10 estimates the landslide sediment delivery based on size, age, and hydrologic connectivity of features. Table 3.11 is a summary of human activity-related landslide delivery broken down by type of human activity and subwatershed.

3.3.8.1 West Canyon Subwatershed

The West Canyon Subwatershed has the largest human-associated contribution, and both roads and harvest are strongly associated with landslide delivery (Tables 3.10 and 3.11). This subwatershed is very steep mountains of the north end of the Marble Mountains. Ownership is primarily Forest Service. Landslides are more abundant than in any other subwatershed, particularly in the drainages of Kelsey Creek and Middle Creek (Figure 3.4). The estimated anthropogenic contribution of 254 tons/sq mi-yr (Table 3.11) is the highest in the Scott River watershed. This subwatershed has had considerable harvest activity, is densely roaded, and underwent severe fires in 1988.

3.3.8.2 East Canyon Subwatershed

The East Canyon Subwatershed has a low rate of sediment delivery from landslides, and that delivery is mainly associated with roads (Table 3.11). This subwatershed covers both the north and south flanks of the Scott Bar Mountains, which are steep, but not as high as the Marble Mountains to the west. Land ownership is largely a mix of National Forest and private timberlands, some in checkerboard pattern, with other private holdings more abundant in the southeast portion. The few landslides occur mostly near the west end of the Scott Bar Range above the great bend of the Scott River (Figure 3.4).

3.3.8.3 Eastside Subwatershed

The Eastside subwatershed has very low landslide delivery. Table 3.10 shows no delivery from non-anthropogenic sources and only a small delivery from anthropogenic sources, which is entirely associated with harvest (Table 3.11). This subwatershed is essentially the watershed of Moffett Creek and is the lowest and driest of the six mountainous subwatersheds. The north half of the area is a mixture of National Forest and private timberlands with inliers of other private lands. The south quarter of the area is largely private timberlands, and the middle parts are a mixture of private grazing land and timberland. No significant landslides were mapped in this subwatershed (Figure 3.4, Table 3.11).

3.3.8.4 East Headwater Subwatershed

The East Headwater Subwatershed was inventoried as having no major landslide delivery in spite of having a history of harvest and mining (Tables 3.10 and 3.11). This subwatershed is the drainage of the East Fork Scott River including Noyes Valley Creek. Surrounded on the south and east by high country of the Scott Mountains, this subwatershed is a mixture of environments. The northwest flank of the Scott Mountains, above the East Fork, are largely a checkerboard of Forest Service and private timberlands. The upper part of South Fork drainage and the drainage of Noyes Valley Creek are largely grazing land with inliers of private timberlands. Only a few landslides occur, primarily on the middle slopes of the Scott Mountains.

3.3.8.5 West Headwater Subwatershed

The West Headwater Subwatershed is the watershed of the South Fork Scott River, reported in detail in the South Fork Scott River Watershed Pilot Study for the Total Maximum Daily Load for Sediment (NCRWQCB, 2005b). The West Headwater Subwatershed has significant landslide delivery, of which about 60 percent is anthropogenic (Table 3.10). The largest anthropogenic contribution is from mining legacy on mafic bedrock along Slide Creek, which is discussed in some detail in the south Fork Pilot Study. As the tables in this report do not include a mining legacy category, this mining legacy is included under the Harvest category in Table 3.11. Landslide contribution per square mile is estimated at only 18 tons/year (Tables 3.10 and 3.11), a low rate considering the steep country and a history of human activity.

3.3.8.6 Westside Subwatershed

The Westside Subwatershed is second only to the West Canyon Subwatershed in total landslide sediment delivery per square mile (Table 3.10). The inventory showed the human activity-related landslide delivery to be significant at 20 tons/yr-sq mi falling about equally in the categories of Roads, Harvest, and Roads-and-Harvest (Table 3.10). This is the largest subwatershed and is underlain by significant areas of granite in the south and mafic rocks in the north (Figure 3.2). The higher country along the crest and east flank of the Marble Mountains is in federal ownership as National Forest and Wilderness. The middle and lower mountainous part is largely in timber company ownership. Both National Forest and private timberlands have been roaded and harvested. Landslide activity is widespread (Figure 3.4).

3.3.8.7 Scott Valley-Eastern Valley Side Subwatershed

The Scott Valley Subwatershed has negligible landslide delivery from either anthropogenic or non-anthropogenic sources (Tables 3.10 and 3.11). The floor of Scott Valley is an alluvial plain sloping gently toward the Scott River from each side. Surrounded by mountains, this valley receives much less precipitation than the surrounding high country. Low relief and dry climate combine to produce a terrain that does not produce landslides. In the north end of the valley Quartz Hill and Chaparral Hill rise above the plain, but they are low enough to participate in the drier climate of the valley bottom and this inventory found no landslides. The east flank of the valley, up to the divide between Scott Valley and Noyes Valley Creek in the south and Moffett

Creek in the north is included in this subwatershed because it too produces almost no landslides (Figure 3.4, Table 3.10).

3.3.8.7 Confirmation by SHALSTAB model

SHALSTAB, a computer model to evaluate risk of shallow landslides was applied in the Scott River watershed by Derksen (2005). This model shows the highest hazard ratings in the areas where the TMDL landslide inventory and USFS studies found the highest incidence of actual landslides (Section 3.3).

3.4 STREAMSIDE SEDIMENT DELIVERY

Streamside sediment delivery was estimated in three categories:

- Soil creep is the downslope migration of soil and rock under the influence of gravity. This is a natural process that probably is little affected by human activities and is considered as a natural background source. It was estimated using SEDMODL2.
- Small streamside discrete mass-wasting and erosion features are the result of lateral stream erosion and a variety of natural and human-influenced causes. These features include bank failure, gullies, small landslides, and other small features.
- Large streamside discrete mass-wasting and erosion features result from both natural and human-induced causes. They generally extend from the stream up onto the mountainside above and include landslides, debris flows, and sites of ongoing wasting. They tend to be long-term ongoing sediment sources.

3.4.1 Soil Creep Contribution

Three approaches were used to estimate sediment delivery associated with soil creep:

1) For comparative purposes, staff investigated the results of other authors who estimated soil creep in the nearby Trinity River and Eel River watersheds.
2) Staff applied to all geologic units the soil creep rate accepted in SEDMODL2 (NCASI, 2003), which includes a function to estimate the soil creep contribution to a stream system.
3) Staff applied the soil creep rate from SEDMODL2 in all geologic units except granitic bedrock and used the delivery rate from the Sommarstrom et al. (1990) granitic sediment Study to the areas of granitic bedrock.

Approach 3 seems to give the most credible estimate.

In their Trinity River Sediment Source Analysis, Graham Matthews and Associates (GMA, 2001, p. 79, Table 48) used a rate of 30 tons/sq mi-yr as a basis to estimate soil creep contribution (Table 3.12). They arrived at this rate by starting with the rate of 75 tons/sq mi-yr derived by Roberts and Church (1986) in the coastal areas. GMA took into account that in the coastal areas the geology is less stable and uplift rates are higher than in the Trinity and used 40 percent of the coastal rate, or 30 tons/sq mi-year, for the Trinity.

In the South Fork Eel River watershed, Stillwater Sciences (1999) used two methods to calculate creep in different geologic terranes. For Coastal Belt and Yager terrane they assumed that soil creep was shallow and used SEDMODL2. They considered it likely that their estimate of 9 tons/sq km-yr (23 tons/sq mi-yr) (Stillwater Sciences, 1999, Table 3.15) is an underestimate but believed that the effect on the overall budget was probably small. For areas in the Franciscan mélange matrix, they considered creep to be soil mantle creep, a deeper process, and applied a rate of 146 tons/sq km-yr (378 tons/sq mi-yr), which they derived from intensive study of one area within the mélange.

In the Scott River watershed, staff estimated the soil creep contribution to the stream system using parameters from SEDMODL2 and applying NRCS STATSGO data on soil strength, density, and depth. SEDMODL2 takes into account not only downslope soil movement from gravity but also downslope soil transfer from biological activity such as animal burrowing and soil attached to roots of fallen trees. Default parameters for SEDMODL2 are 36-inch soil depth, creep rates of 1 mm/year for slopes less than 30 percent and 2 mm/year for slopes greater than 30 percent, and contribution length equal to twice the stream length, to account for both banks.

A 10-meter digital elevation model (DEM) of the Scott River watershed shows 748.8 sq mi (92 percent of the watershed) as being steeper than 30 percent grade. The remaining 64.7 sq mi (eight percent of the watershed) that is lower than 30 percent grade lies almost entirely in the floor of Scott Valley (the Scott Valley Subwatershed).

Calculation of the soil creep contribution to a stream system using SEDMODL2 depends on the hydrography used. A higher density of hydrographic depiction will yield a higher estimate of soil creep contribution, because it shows a greater length of stream banks. The hydrography used to calculate soil creep contribution, the densest hydrography available, is a hydrography GIS layer developed by David Lamphear at Humboldt State University, College of Natural Resources and Sciences Institute for Forest and Watershed Management, as supplemented by RM on the basis of field studies. Lamphear digitized the USGS 1:24,000 scale blue-line streams into GIS. As RM was doing road survey work, they found that there were many more road/stream crossings than the USGS stream coverage would indicate. Accordingly they used the 10-meter DEM to supplement the stream coverage and show the streams that roads crossed as high in the watershed as the highest road crossing. While this may not capture the uppermost parts of many small streams, this is the best available data.

Slopes in much of the Scott River watershed average very steep. The 10-m DEM shows 92 percent of the slopes steeper than 30 percent grade. Furthermore, large areas have slopes between 50 percent and 100 percent grade. Accordingly, staff calculated soil creep assuming that the grade of all slopes is steeper than 30 percent.

The assumptions in this calculation are as follows:

Slope	All slopes steeper than 30% grade
Creep rate	2 mm/year
Soil depth	3 feet
Tonnage	1.35 tons/cubic yard

Table 3.13 summarizes the soil creep contribution estimates in the Scott River watershed by subwatershed. In the steep country of the subwatersheds surrounding Scott Valley, contributions range from 29 to 37 tons/sq mi-yr, and the Scott Valley subwatershed contributes only about 13 tons/sq mi-yr. In subwatersheds other than Scott Valley, because assumptions used for slope, creep rate, and soil depth are the same, differences in tons/sq mi-yr are the function of differences in stream miles per square mile.

In a second calculation, staff applied the SEDMODL2-derived soil creep rates to streams in the Sedimentary/Metamorphic, Mafic/Ultramafic, and Quaternary units, and applied the sediment contribution rates from the GSS to streams on Granitic substrate. Table 3.14 shows the results of this exercise minus the granitic contribution. The granitic contribution from Sommarstrom and others (1990) is included in the sediment contribution summary in Section 3.5.1. In Sommarstrom's calculation, soil creep is not separated out from other streamside erosion processes. However, in the final calculations in section 3.5, soil creep is accounted for.

Sommarstrom and others (1990, p. 5-3) concluded that:

> Granitic terrane streambanks average 382 tons per mile per year. Nearly three times the average streambank erosion is estimated for Boulder and Fox Creeks because of large areas of upper bank scour. About 17 miles of granitic streams in the Study Area are gutted on their upper banks. In most cases, this occurred with the 1964 flood. There has been only limited revegetation of these banks since 1964, as viewed in historic and current aerial photos. This activity appears unrelated to timber harvest as it generally occurs in upper watershed areas where little if any harvesting has occurred.
>
> Total erosion is estimated to be about 340,450 tons per year. Road cuts constitute 40 percent of this amount, and streambanks 23 percent.

3.4.2 Streamside Mass Wasting and Erosion Features - Stratified Random Sampling

Random sampling is a standard and effective means to characterize a population. A simple random sample is applicable where a population is all governed by the same major factors. In the Scott, however, a number of different factors apply to different areas in the landscape. A more efficient system of sampling is to divide the landscape into more nearly homogeneous units and apply stratified random sampling. One accepted description of this process is:

"A stratified random sample is obtained by separating population elements into non-overlapping groups (strata) and selecting a simple random sample from each stratum" (http://www.sph.uth.tmc.edu:8053/biometry/Elee/ph1745/doc/Strata.ppt accessed 4/6/05).

Stratified random sampling provides a systematic way to include in the sampling more than one important factor in sediment generation. A major factor that affects the inherent erodibility and rate of sediment contribution from a given locality in the study area is bedrock geology.

These aggregated geologic units are described in detail in the document, *Scott River Basin Sediment TMDL Stratified Random Sampling for Streamside and Road-Associated Sediment*

Contribution (Coates and McFadin, 2004). Table 3.1 summarizes the areal extent of these units in the Scott River watershed. This GIS geology coverage (modified from Saucedo et al., 2000) has proved satisfactory for the job at hand. Field observations in October and November of 2003 and May-July of 2004 at computer-generated random stream sample locations showed no significant differences between geologic units shown on the GIS geology coverage and geologic units observed on the ground.

Stream reaches for streamside sampling were chosen using GIS to select stratified random reaches along streams using the four geologic units as sampling strata (Figure 3.5). During sampling of sites on bedrock units, observations were recorded both of geology, to verify the GIS site selection, and of evidence of fire and timber harvest. During sampling of sites on Quaternary deposits, observations were recorded on presence or absence of riprap or levee, fencing of riparian corridors, adjacent land use, and other factors.

In selecting stream segments to sample, a digital elevation model was applied to define a minimum area of drainage into a stream before considering the stream valid for selecting a random sampling reach. A satisfactory minimum area was found to be one half square mile.

Within each sampled stream segment, each erosion feature that has contributed five cubic yards or more of sediment to the stream was inventoried. Such features include debris slides, gullies, stream bank failures, fill failures, road and skid-trail washouts, small landslides, and other features. Some features are not obviously associated with human activities while others are associated with skid trails, stream crossings, landings, road ditches, road cuts or fills, or other anthropogenic features. Association or lack of association with anthropogenic features was noted. The eroded void of the feature was measured or estimated, and the percent of that volume that entered the stream system was estimated. Age of the feature was estimated on the basis of freshness of scarps and sediment, age or maturity of vegetation within the feature, presence of the feature in aerial photos, or other relevant criteria.

In all, 63 segments with a total length of 21.3 miles were sampled. The total estimated length of streams in the watershed is 2,500 miles.

3.4.3 Effects of Multiple Interacting Human Activities in the Scott River Watershed

Most of the Scott River watershed has been affected by mining, timber harvest, or agriculture over the past one hundred fifty years and longer, and the effects from repeated episodes of human activities are evident in many areas.

Different parts of the landscape show abundant roads from both mining and timber harvest, skid trails of several ages, harvest units of several ages, evidence of mining both in the riparian zones and on mountainsides, and conversion from wetlands and forest to agricultural land. Past filling of channels and valley bottoms by sediment related to human activities has caused bank erosion. Downcutting into valley-bottom fill deposits generates further second-generation sediment. Sidecutting into banks resulting from aggradation adds large amounts of sediment to the channel and triggers gullying. Old roads and skid trails contribute varying amounts of sediment depending on design, age, and position in the landscape. Sediment is generated by landslides and debris flows are triggered, or reactivated, by human activities.

It is clear that both human activities and natural processes affect sediment contribution from both dispersed and discrete sources. At the present state of knowledge, however, it is not possible to determine with certainty for each sediment delivery feature the exact proportion of natural and human-activity-induced contribution. Lacking that certainty, Regional Water Board staff used the best available information to estimate the human-caused portion of sediment contribution by sediment delivery features that were not directly associated with a particular anthropogenic feature. Field observations and aerial photographs of several ages were used along with GIS coverages of disturbance, including extent and age of timber harvest, extent and date of fires, and extent of roads, to estimate the long-term effect of human activities on sediment contribution from features in each stream reach sampled.

The sources of information used in this process include:

- California Department of Forestry GIS coverage of timber harvest. This data goes back only to 1990 but is complete from 1990 to present.
- USFS GIS coverage of timber harvest. This data set includes pre-1990 information but does not include all timber harvest on Government land.
- USGS DOQQ Aerial photographs from 1993 and 1998.
- USFS Landslide data. (please refer to the data discussion in section 3.3.6)
- Vestra Landslide data. (please refer to the data discussion in section 3.3.8)
- USFS “Tweener” GIS coverage. This data documents erosional and mass wasting features that occur between road/stream crossings. This was compiled by the USFS from Road Sediment Source Inventories, 1999 to 2001.
- USFS “Damage_all” GIS coverage. This theme captures 1997 Flood damage to roads and other Forest facilities.
- USGS Mineral Resources Data System. Documents historical mining activities.
- Vestra-developed GIS roads coverage.
- USFS-developed stream layer.
- Field observations of human activity not documented elsewhere.

Water Board staff evaluated each of the above data sets in estimating the level of human contribution in each subbasin, upstream and upslope of the sediment sample survey reach. Also used were the USFS and CDF timber harvest records, which include the level of impact and age of the harvest, and additional harvest areas that staff digitized from the USGS aerial photographs in which impact and age of harvest was indeterminate. The Vestra and USFS landslide data used documented human-related or natural cause of slides. The impact of road-associated failures documented in the USFS “Damage_all” and “Tweener” coverages and those documented by Water Board staff during field work were included in the analysis. Analysis by Water Board staff incorporated all of these factors. The Human Contribution Factor assigned to each sample survey reach was based on the type, extent, and age of the activity and the proximity to the sample survey location.

Table 3.15 summarizes the estimates of EMIHAs for each stream reach sampled in the Scott River watershed. In this table:

- The stream reaches are the reaches selected by stratified random sampling.
- The Total Contribution column gives the contribution from streamside discrete features including bank failure, landslides, and gullies that were not associated directly with a proximate human activity in field examination.
- The Human-Activity Related Contribution column gives the estimate of proportion of sediment contribution resulting from human activity, in categories of 25 percent. A zero means that the estimate was closer to zero than to a quarter. A 0.25 estimate means that the estimate was closer to one-fourth than to zero or to one half, and so forth.
- Comments are primarily a narrative description of amount, age, and intensity of human activity adjacent to, and upstream of, the stream reach summarized from GIS coverages, aerial photographs, and field observations.

Four sampled stream reaches were selected as examples to illustrate the factors that were taken into account. Figure 3.6 shows the locations and relative sizes of the watersheds above these sample reaches. Each of these areas is shown in more detail in two figures to illustrate the factors taken into account. In each pair of figures, the first is an orthophoto or orthophoto mosaic with an overlay of timber harvest as depicted in CDF GIS coverage and additional timber harvest interpreted by Regional Water Board staff on aerial photos and/or in the field. Because the digital orthophoto quarter quads used come from both 1993 and 1998 photography, not all of the orthophoto coverage is the same age.

The second figure in each pair shows the same GIS and interpretive information as the first, but without the visual clutter (and verification) of the orthophoto. Note that while each figure of a pair is the same scale, different pairs are different scales. Figures 3.7 to 3.14 are examples of interpretation of different percentage categories of EMIHAs.

Example in zero percent category

Figure 3.7 (1993 and 1998 photography) shows a drainage basin of 2,800 acres upstream of the terminal point of stream reach M-09-04. This area is high in the Marble Mountains and heads at the divide between the Scott River and Salmon River watersheds. The GIS layers show timber harvest over 22 acres in 1978 and 111 acres in 1992 (total 133 acres, 5 percent of the area). Photointerpretation shows an additional 244 acres (9 percent of the area) harvested (Figures 3.7 and 3.8). Several roads lie within the area. Because only 14 percent of the area has been harvested and there is little evidence of other disturbance, staff estimated that anthropogenic contribution was closer to zero than to 25 percent.

Example in 25 percent category

Figure 3.9 (1998 photography) shows several factors used in interpreting anthropogenic sediment delivery. This small drainage basin covers 390 acres upstream of the terminal point for streamside sample reach S-05-04. GIS layers from CDF and DOQQs from 1993 and 1998 aerial photos were examined. The CDF GIS layers show pre-1997 timber harvest over 240 acres (61 percent of the area). On the DOQQs, Regional Water Board staff, interpreted thinned timber and skid trails to show an additional 64 acres of harvest in two areas in the head and on the north side of the basin, bringing harvest in the basin to 304 acres or 78 percent of the basin (Figures 3.9 and 3.10). The only permanent road within the basin is a short segment that crosses the headwaters. Although the area of harvest was high, 78 percent, the harvest practices were low impact, and staff estimated the anthropogenic contribution to be closer to one fourth than to one half.

Example in the 50 percent category

Figure 3.11 (1993 photography) shows the headwater area of North Fork French Creek and sample reach G-14-04. The available GIS coverage does not show timber harvest plans in this area, but interpretation of aerial photos shows a timber harvest area covering the mountainsides both north and south of the creek along the sampling area and other harvest areas higher in the basin (Figures 3.11 and 3.12). This is a granitic area (Figure 3.2) and the DG that makes up the surface is known to ravel extensively when disturbed. The photos (Figure 3.11) show a large amount of bare ground exposed in the harvest area, which is a steep slope. For these reasons, staff estimated anthropogenic contribution in this area to be in the 50 percent range.

Example in the 75 percent category

Figure 3.13 (1993 and 1998 photography) shows the drainage basin of North Fork Kelsey Creek, which has had extensive and intense management activities immediately upstream of the terminal point of sample reach M-18-04. Of the 11,110 acres in this drainage, USFS GIS coverage shows 2,060 acres (18.5%) as included in timber harvest plans. Most of these areas are immediately upstream of, and draining into, the sample area. Roads are abundant in the harvested area. Landslides are significantly more abundant in the harvest areas than in unharvested areas to the west and south, and aerial photos show association between several landslides and harvest activity (Figures 3.13 and 3.14). Because of the association with extensive disturbance, staff estimated anthropogenic contribution in this area to be in the 75 percent range.

The proportion of natural and anthropogenic contributions generated in Table 3.15 is applied to streamside large discrete features in Section 3.4.5 and to streamside small discrete features in Section 3.4.6. This application is based on the assumption that the contribution proportions and rates estimated for the randomly sampled areas are applicable throughout the Scott River watershed.

3.4.4 Estimation of Sediment Delivery from Small and Large Discrete Features

The sediment delivery per stream mile from both large and small features in all four geologic units was estimated using data from all random samples throughout the Scott River watershed. Then for the purpose of the TMDL study the delivery rate for each geologic unit, in tons/sq mi-yr, was applied in each subwatershed.

Streamside sediment sources were classified in two categories: streamside large discrete features and streamside small discrete features. The large features generally are long-term continuing sources of sediment and typically originate on, or extend up onto, the mountainside. The small-features category includes streambank failure, gullies, and a variety of other small failures that mostly deliver episodically to the stream.

While there can be some overlap in the middle ground, the large and small feature categories have fundamental differences in duration and mechanism. Most of the large features have much in common with the landslides that were inventoried by the aerial photo survey. Many in the large-feature category, however, are small enough that they would be marginal to be picked up in the aerial photo survey. In addition, some, although large enough to fit the criteria for the aerial photo survey, lie in steep inner gorges and are too obscured by trees and shadow to pick out on the photos. Also, in this extremely steep country, photo angle can be critical in finding and defining these features.

Some features, both large and small, are clearly associated with a specific anthropogenic feature such as a road or a road-stream crossing. These are counted simply as related to human activity.

3.4.5 Streamside Large Discrete Features

Ten features examined in the Scott River watershed meet the criteria of this category. Though small in number, these features are significant and generally long-term contributors to stream sediment. In Table 3.16, the average annual large-discrete-feature contribution per stream mile in the Scott River watershed is calculated on the basis of the random sampling along streams. Contribution from large features on granitic substrate is totaled separately from the other three geologic units for the purpose of comparison, as a separate calculation was done applying rates from the GSS to areas of granite.

In Table 3.17, the rates estimated in Table 3.16 are applied to individual sub-watersheds throughout the Scott River watershed, based on stream miles in Quaternary, Granitic, Mafic, and Sedimentary/Metamorphic substrates. The Scott Valley Subwatershed is not included as no large discrete features were found there and slopes are lower than in the areas where such features occur. In the bottom half of Table 3.17 is a summation of estimated large-feature sediment contribution. The first block shows tons per year for each subwatershed and for the Scott and tons/sq mi-yr per subwatershed and for the Scott including granitic substrate, based on SEDMODL2 and RM road survey rates for all geologic units. The second block shows results from the same sources, but without results from granitic substrate. These rates are carried forward to the summary in Section 3.5.

3.4.5.1 Feature 92 – A Special Case

Feature 92 of the air-photo landslide inventory, discussed in the South Fork Pilot Study (NCRWQCB, 2005b, Figure 2, Table 5), is not a landslide. It is a stream segment that has had extreme erosion. While this feature is not within one of the stratified random samples of stream segments, its very size puts it in a category that cannot be ignored. Staff visited one locality in the lower-middle portion of the feature and found it at that spot to be a steep-sided, downcutting gully as deep as 60 feet and as wide as 150 feet rim-to-rim. At that spot, it is essentially V-shaped in cross section, and the walls are so bare as to be conspicuous on aerial photographs. This is much larger than any other active gully, natural or anthropogenic, that staff have found in

the Scott River watershed. USFS data suggest that this feature originated in 1944 as a failure on steep upper slopes of the mountainside in an area that has not undergone mining or timber harvest. The feature has evolved over the years and created a debris flow channel extending from the upper flank of Craggy Peak down to East Boulder Creek.
Estimated dimensions and yield of Feature 92:

5,000 feet long
Avg. depth 30 feet
Avg. width 100 feet
V-shaped cross section = Avg. 1500 sq ft
1,500 sq ft (cross section) x 5,000 ft (length) = 7,500,000 cu ft
7,500,000 cu ft / 27 cu ft per cu yd = 280,000 cu yd
280,000 cu yd x 1.35 tons per cubic yard = 378,000 tons

Assuming an age of 60 years, then average yield has been 378,000/60 = 6,300 tons per year. But this needs some interpretation.

The total volume calculated above assumes that there was no prior depression where the gully now is, which is probably not true; water and sediment flowing downhill from the area of origin would follow the lowest course. The USGS 1:62,500 scale topographic map shows Feature 92 as the only blue-line stream incised into the west flank of Craggy Peak, suggesting that it existed as a stream course before the 1944 debris flow event.   Assuming that the course of Feature 92 followed one of these shallow depressions to channel the water in the first place, staff decrease volume and tonnage by ten percent and arrive at a yearly average of 5,670 tons.   Aerial photo analysis reveals that Feature 92 is a debris flow channel that has had at least two debris flows, probably in 1964 and 1997, in addition to the 1944 event that originated the channel, and any undocumented events that might have taken place between 1944 and the 1980 photos. However, debris flows are not the only source of erosion and sediment delivery. The V-shaped stream channel and steep, unvegetated gully walls indicate that downcutting of the channel and backwasting of the walls are ongoing processes.

Sediment is delivered from Feature 92 every wet season when the stream runs, but delivery has been punctuated by the episodic debris flow events, the timing of which is unpredictable. Seeking the average annual contribution over a long period, staff include the debris flow events as an integral part of the long term sediment delivery. 5,670 tons/yr divided by 43 sq mi = 132 tons/sq mi-yr in the South Fork Scott River subbasin. This figure is included in natural sediment delivery in Section 3.5.

3.4.5.2   East Boulder Creek – A Special Case

One reach of East Boulder Creek, G-06-04, has four large erosion features strung together along 300 m of stream course. This in an anomalous stream segment that is incising into glacial till deposits on the valley floor, and the features described are undercut banks on the outside of bends in the stream course. Although limited timber harvest has taken place upstream, and some legacy roads remain, no direct connection was seen between human activity and the downcutting. For the TMDL estimate, staff attribute it to natural causes. Staff combined the four described features into one causal feature, estimated sediment contribution for the last twenty years, and calculated the rate on that basis. This figure is applied in Table 3.22. The calculation is as follows:

$$(7255 \text{ yd}^3) \times (1.35 \text{ tons/yd}^3) / (20) / (43.91) = 11.15 \text{ tons/sq mi-yr}$$

3.4.6 Streamside Small Discrete Features

The rate of contribution per stream mile from streamside small discrete features throughout the Scott River watershed was calculated on the basis of stream survey data collected from all geologic units in 2003 and 2004 (Table 3.18). Delivery from features that are clearly associated with an anthropogenic feature were accounted for in the left of the table. To the right in Table 3.18 is delivery from features for which direct association with human activity is not obvious within the stream reach where sampling took place. A factor generated in Table 3.15 was applied to estimate anthropogenic contribution to take into account the effects of multiple interacting human activities in the watershed produced by many decades of human activity.

Table 3.19 presents the same calculation as Table 3.18 in areas of Quaternary, Mafic, and Sedimentary/Metamorphic substrate. However the delivery rate from granitic substrate is taken from the Granitic Sediment Study instead of from data collected in this study. The total delivery estimated by the two different approaches is so close as to be within the margin of error.

Estimates of sediment delivery per geologic unit per subwatershed are calculated in Table 3.20 for small discrete features that have no direct human-activity association. Estimates of rates of sediment delivery attributed to different human activities are summarized in Table 3.21.

3.4.7 Callahan Area Dredger Tailings

Gold dredging along a 4.7 mile reach of the Scott River below the town of Callahan from 1934 to 1948 created disruptions of channel processes as well as in surface and subsurface hydrology that persist today. Dredging in the river and adjacent terrace deposits went as deep as 50 feet below river level. This process not only left behind windrows of cobble gravel, but it disrupted the stratigraphy of the deposits greatly increasing permeability as fine material was washed out. Consequently a significant part of the river flows underground through this stretch and the surface flow dries up most summers (Hesseldenz et al., 1999; U.S. Forest Service, 1997). Lateral cutting of the river into the dredger tailings along the west side of the river delivers sediment into the channel, but the quantity of sediment delivered is not clear. Sediment discharged from the dredger tailings was not included in the TMDL calculation.

3.5 SEDIMENT ANALYSIS SUMMARY, TMDL, ALLOCATIONS, & MARGIN OF SAFETY

3.5.1 Sediment Source Analysis Results

The results of the sediment source analysis are summarized in Table 3.22 in tons per square mile per year from different natural and anthropogenic sources. The bottom section of Table 3.22 summarizes estimates of current natural and human-activity-related delivery and calculates the percentage of the total contribution above natural delivery. Sources of information for these calculations are as follows:

- Delivery from discrete features is taken from stream surveys.
- Delivery from landslides comes from the aerial photo survey with field checking.
- Road-related delivery is taken from SEDMODL2 and the RM road survey for Quaternary, Mafic, and Sedimentary/Metamorphic geologic units and from the Scott Granitic Sediment Study (Sommarstrom et al., 1990) in areas of Granitic substrate for reasons explained in Section 3.1.5.
- In Scott Valley, delivery from discrete features and soil creep was calculated only from observations in Scott Valley and not extrapolated from values in the mountainous subwatersheds.

3.5.2 Sediment TMDL

This TMDL is set equal to the loading capacity of the Scott River and its tributaries. The TMDL is the estimate of the total amount of sediment, from both natural and human-caused sources, that can be delivered to streams in the Scott River watershed without exceeding applicable water quality standards. Staff are assuming that there can be some increase above the natural amount of sediment without adverse effects to fish habitat. Staff postulate this because fish populations were thriving throughout the Klamath River watershed after human activities had begun to produce some sediment. For the Scott River, the sediment TMDL is set equal to 125 percent of natural sediment delivery, based on past experience in other Northern California watersheds.

For the Noyo River, the U.S. EPA (1999) used a reference time period to calculate the sediment TMDL. The TMDL was set at the estimated sediment delivery rate for the 1940s. Because salmonid populations were substantial during this time period, which was assumed to be a quiescent period between the logging of old growth at the turn of the century and logging of second growth in the middle of the 20th century, U.S. EPA postulated that there could be increases above the natural amount of sediment and still maintain healthy watershed conditions. Analysis of sediment sources during this period indicates that there was about one part human induced sediment delivery for every four parts natural sediment delivery (i.e. a 1:4 ratio, or a 25% increase).

The U.S. EPA reached similar results in the TMDL analysis of the Trinity River (USEPA, 2001). For that TMDL U.S. EPA used reference streams within the watershed to calculate TMDLs for all the subwatersheds of the Trinity. Again, the reference streams were subwatersheds in which there was some management accompanied by healthy watershed conditions. As with the Noyo, it appeared that in these watersheds fish populations could be supported under TMDLs set at a level equivalent to a 4:1 ratio.

Based on these analyses, staff have determined that setting the TMDL at 125 percent of natural sediment delivery is appropriate for the Scott River. Using the estimated natural sediment delivery rate of 448 tons/sq mi-yr (Table 3.22), the TMDL for the Scott River (rounded to two significant figures) is:

TMDL = Loading Capacity = (125%) x (448 tons/sq mi-yr) = 560 tons/sq mi-yr

Because of the natural variations in sediment delivery, the TMDL is to be evaluated as a ten-year, rolling average of total annual sediment yield. The ratio approach has several potential advantages. Stillwater Sciences (1999) indicates that looking at the ratio of human to natural sediment sources can detect the effects of land use changes better than an annual sediment loading alone, because the ratio may very with hydrology less than the annual sediment load. The ratio could be measured periodically and provide an indication of progress toward meeting sediment reduction goals. The ratio may also be less dependent upon spatial and hydrologic variability.

The approach taken focuses on sediment delivery, rather than on a more direct measure of salmonid habitat (i.e., instream conditions). Sediment delivery can be subject to direct management by landowners (for example roads can be well maintained and landslides mitigated).

While it would be desirable to be able to mathematically model the relationship between salmon habitat and sediment delivery, these tools are not available for watersheds with landslides and road failure hazards. Sediment movement is complex both over space and through time. Sediment found in some downstream locations can be the result of sediment sources far upstream; instream sedimentation can also be the result of land management from decades past. Nonetheless, management activities clearly can increase sediment delivery, and instream habitat can be adversely affected by increased sediment inputs. Therefore it is reasonable to link human activities to decreased stream habitat quality. The French Creek project, discussed in Section 2.4.2.7, demonstrates the linkage between upslope and instream conditions, and the potential for improvement in instream habitat that can result from upslope sediment delivery reductions.

The approach also relies upon the assumption that salmon populations can be self sustaining even with the yearly variation of natural rates of erosion observed in the 20th century. Although the sediment delivered to the streams varied, salmon adjusted to the natural variability by using the habitat complexity created by the stream's adjustments to the naturally varying sediment loads.

3.5.3 Load Allocations

In accordance with EPA regulations, the loading capacity (TMDL) is allocated to the various sources of sediment in the watershed, with a margin of safety. That is:

TMDL = sum of the wasteload allocations for individual point sources
+ sum of the load allocations for nonpoint sources
+ sum of the load allocations for background sources.

The margin of safety in this TMDL is not added as a separate component of the TMDL. Instead it is incorporated into conservative assumptions used to develop the TMDL. As there are no point sources of sediment in the Scott River watershed, the wasteload allocation for point sources is set at zero.

In addition to ensuring that the sum of the load allocations equals the TMDL, the Regional Water Board considered several factors related to the feasibility and practicability of controlling various nonpoint sources of sediment. The load allocations for nonpoint sources reflect professional judgment as to how effective best management practices are in controlling these sources. For example, techniques are available for greatly reducing sediment delivery from roads (Weaver and Hagans, 1994). In the Scott River watershed, the effectiveness of mitigation measures with respect to roads has been demonstrated in the French Creek watershed and in improved road design in other areas since implementation of the Forest Practice Rules.

For the Scott River TMDL, source categories that are more controllable receive load allocations based on a higher percentage reduction from current levels. For example, road stream crossing failures are more readily controlled than road related mass wasting, particularly in weathered granite. Therefore, the load allocation for road stream crossing failures is based on a loading reduction of 75 percent, whereas the load allocation for road related mass wasting is based on a loading reduction of 42 percent.

The load allocations for the Scott River watershed are presented in Table 3.23. The allocations clarify the relative emphasis and magnitude of erosion control programs that need to be developed during implementation. The load allocations are expressed in terms of yearly averages (tons/sq mi-yr). They could be divided by 365 to derive daily loading rates (tons/sq mi-day), but the Regional Water Board is expressing them as yearly averages, because sediment delivery to streams is naturally highly variable on a daily basis. In fact, the Water Board expects the load allocations to be evaluated on a ten-year rolling average basis, because of the natural variability in sediment delivery rates. In addition, the Water Board does not expect each square mile within a particular source category to necessarily meet the load allocation; rather, the Water Board expects the average for the entire source category to meet the load allocation for that category.

3.5.4 Margin of Safety

The Clean Water Act, Section 303(d) and the associated regulations at 40 CFR §130.7 require that a TMDL include a margin of safety that takes into account any lack of knowledge concerning the relationship between the pollutant loads and the desired receiving water quality. The margin of safety may be incorporated implicitly by making conservative assumptions in calculating loading capacities, waste load allocations, and load allocations (USEPA, 1991). The margin of safety may also be incorporated explicitly as a separate component in the TMDL equation. For the Sediment TMDL analysis, conservative assumptions were made that account for uncertainties in the analysis.

Specific conservative assumptions used to account for margin of safety:

- Section 3.4.1. In estimating sediment delivery by soil creep it was recognized that the hydrography used directly affects the estimate of delivery from this source. Because no available hydrography GIS layer shows all streams, as evidenced in field studies, the delivery from this natural source is underestimated. This underestimate affects the allocation of anthropogenic sediment, as the allocation is calculated as a percentage of the natural delivery.

- Ages of small features tended to be estimated low. The majority of small features described and estimated were along streams and the majority of these are natural. This would tend to result in higher yearly rates of sediment delivery for these features and is therefore conservative. If features attributed to the 1997 flood event actually were initiated before this event, yearly rates of sediment delivery estimated for these features would be higher and are therefore conservative in the context of calculating the TMDL.

- The estimation of EMIHAs is a part of the margin of safety. Some anthropogenic features are not accounted for in their proper category. For example, the VESTRA-developed GIS layer of roads used under-represents roads and does not include skid trails. In some areas only major haul roads are included, which means that many temporary roads and skid roads that can increase erosion remain unaccounted for in that road survey. Addition of the EMIHA factor accounts for roads and skid trails that are not documented in the survey.

3.5.5 Seasonal Variation and Critical Conditions

The TMDL must discuss how seasonal variations were considered. Sediment delivery in the Scott River watershed inherently has considerable annual and seasonal variability. The magnitudes, timing, duration, and frequencies of sediment delivery events fluctuate naturally depending on intra- and inter-annual variations in storm patterns. Because the storm events and the mechanisms of sediment delivery are largely unpredictable year to year, the TMDL and load allocations are designed to apply to the sources of sediment, not the movement of sediment across the landscape, and to be evaluated on the basis of a ten-year rolling average. The Water Board assumes that by controlling the sources to the extent specified in the load allocations, sediment delivery will be controlled within an acceptable range for supporting aquatic habitat, regardless of the variability of storm events.

The TMDL must also account for critical conditions for stream flow, loading, and water quality parameters. Rather than explicitly estimating critical flow conditions, this TMDL uses indicators that reflect net long term effects of sediment loading and transport for two reasons. First, sediment impacts may occur long after sediment is discharged, often at locations downstream of the sediment source. Second, it is impractical to accurately measure sediment loading and transport, and the resulting short term effects, during high magnitude flow events that produce most sediment loading and channel modifications.

CHAPTER 4. TEMPERATURE

Key Points:

- This chapter presents an analysis of the factors that affect stream temperatures in the Scott River and its tributaries.

- Regional Board Staff identified five factors influenced by human activities in the Scott River watershed that have affected, or have a potential to affect stream temperatures. The five factors are: stream shade, stream flow via surface diversion, stream flow via changes in groundwater accretion, channel geometry, and microclimate.

- Regional Water Board staff investigated the effects of human activities using a stream temperature model. Stream temperature model applications were developed for the Scott River, South Fork Scott River, East Fork Scott River, and portions of Houston and Cabin Meadows creeks.

- The analysis of factors affecting the temperature of the Scott River and its tributaries indicate that human activities have resulted in significant increases in temperature in many areas of the watershed, small to modest increases in other areas of the watershed, and that removal of vegetation could cause temperature increases in the future.

- The mainstem Scott River has been drastically altered over the past 170 years. During that time the following changes have occurred:
    - The beaver population has been dramatically reduced.
    - The river has been straightened and levees have been built.
    - Flows have been diverted.
    - The extent and quality of riparian forests has been drastically reduced.
    - A number of periods of increased sediment loads have occurred.

- The primary human-caused factor affecting stream temperatures in the Scott River watershed is increased solar radiation resulting from reductions of shade provided by riparian vegetation.

- Groundwater inflows are also a primary driver of stream temperatures in Scott Valley. The temperature of the Scott River is affected by groundwater in two ways.

Key Points, continued:

First, groundwater accretion directly affects stream temperature by direct addition of cold water, changes in volume, and transit time. Second, the elevation of groundwater affects the ability of riparian tree species to thrive and reproduce, which indirectly affects stream temperatures by increasing exposure to solar radiation.

- Diversions of surface water lead to relatively small temperature impacts in the mainstem Scott River, but have the potential to affect temperatures in smaller tributaries, where the volume diverted is large relative to the total flow. Effects of surface diversions on stream temperatures may be significant when effects of human activities are considered cumulatively.
- Microclimate alterations have the potential to increase stream temperatures. The magnitude of such increases is small to moderate.
- This TMDL uses effective shade as a surrogate measure of solar loading.
- Current and potential effective shade estimates were developed at the watershed-scale using a computer model. The results of the modeling exercise provide an estimate of the loading capacity of the watershed, and were used to develop load allocations at the watershed level. The results should not be used to define load allocations at the site-specific level.
- The temperature TMDL for the Scott River watershed is the adjusted potential effective shade conditions for the date of the summer solstice, as expressed in Figure 4.34 and Table 4.10.
- Further study is required to better understand the interaction of groundwater and surface water.
- Stream temperature conditions are expected to benefit from actions taken to reduce sediment loads.

4.1 INTRODUCTION

This chapter presents the supporting technical analysis for the Scott River Temperature TMDL. The analysis investigates the factors that determine stream temperature conditions in the Scott River and its tributaries. The analysis was developed using the best available information.

The objective of this analysis is to evaluate and quantify the impacts of human activities on the temperature of the Scott River and its tributaries, and to provide an understanding of stream heating processes so that sources of the impairment can be effectively addressed. Specifically, the analysis addresses the following questions: "Have water temperatures been altered by human activities?", and "Have water temperatures been increased more than 5^{o} F?" These questions must be answered to evaluate current conditions in relation to the Water Quality Objective for Temperature (see Table 2.1).

Please note that all figures and tables for this chapter are located towards the end of this Staff Report.

4.1.1 Temperature Sources: Stream Heating Processes

Water temperature is a measure of the total heat energy contained in a volume of water. Stream temperature is the product of a complex interaction of heat exchange processes. These processes include heat gain from direct solar (short –wave) radiation, both gain and loss of heat through long-wave radiation, convection, conduction, and advection, and heat loss from evaporation (Brown, 1980; Beschta et al., 1987; Johnson, 2004; Sinokrot and Stefan, 1993; Theurer et al., 1984).

- Net direct solar radiation reaching a stream surface is the difference between incoming radiation and reflected radiation, reduced by the fraction of radiation that is blocked by topography and stream bank vegetation (Sinokrot and Stefan, 1993). At a given location, incoming solar radiation is a function of position of the sun, which in turn is determined by latitude, day of the year, and time of day. During the summer months, when solar radiation levels are highest and streamflows are low, shade from streamside forests and vegetation can be a significant control on direct solar radiation reaching streams (Beschta et al., 1987). At a workshop convened by the State of Oregon's Independent Multidisciplinary Science Team, 21 scientists reached consensus that solar radiation is the principal energy source that causes stream heating (Independent Multidisciplinary Science Team, 2000).

- Heat exchange via long-wave radiation at a stream surface is a function of the difference between air temperature and water surface temperature (Sinokrot and Stefan, 1993;

ODEQ, 2000). Long-wave radiation emitted from the water surface can cool streams at night. Likewise, long-wave radiation emitted from the atmosphere and surrounding environment can warm a stream during the day. During the course of a 24-hour period, heat leaving and heat entering a stream via long-wave radiation generally balance (Beschta, 1997; ODEQ, 2000).

- Evaporative heat losses are a function of the vapor pressure gradient above the stream surface and wind conditions (Sinokrot and Stefan, 1993). Evaporation tends to dissipate energy from water and thus tends to lower temperatures. The rate of evaporation increases with increasing stream temperature. Air movement (wind) and low vapor pressures (dry air) increase the rate of evaporation and accelerate stream cooling (ODEQ, 2000).

- Convection describes heat transferred between the air and water via molecular and turbulent motion. Heat is transferred from areas of warmer temperature to areas of cooler temperature. The amount of heat transferred by this mechanism is generally considered low (Brown, 1980; Sinokrot and Stefan, 1993).

- Conduction is the means of heat transfer between the stream and its bed. In shallow streams, solar radiation may be able to warm the streambed (Brown, 1980). Bedrock or cobbles on the streambed may store heat and conduct heat back to the water if the bed is warmer than the water (ODEQ, 2000). Likewise, water can lose or gain heat as it passes through subsurface sediments during intra-gravel flow through gravel bars and meanders. Bed conduction is a function of the thermal conductivity of the bed and the temperature gradient within the bed (Sinokrot and Stefan, 1993). A streambed that has absorbed radiant energy during the day will conduct that energy back to the stream at night.

- Advection is heat transfer through the lateral movement of water as stream flow or groundwater. Advection accounts for heat added to a stream by tributaries or groundwater. This process may warm or cool a stream depending on whether a tributary or groundwater entering the stream is warmer or cooler than the stream.

Each of the heat fluxes discussed above can be represented by mathematical equations. By adding the values of the fluxes for a particular location, the net of the heat fluxes associated with all of these processes can be calculated (Theurer et al., 1984; Sinokrot and Stefan 1993). The net heat flux represents the change in the water body’s heat storage. The net change in storage may be positive, leading to higher stream temperatures, negative, leading to lower stream temperatures, or zero such that stream temperature does not change.

Of the processes described above, solar radiation is most often the dominant heat exchange process. In some cases and locations advection has a great effect on stream temperatures by diluting heat loads via mixing of colder water. Although the dominance of solar radiation is well accepted (Johnson, 2004; Johnson, 2003; Sinokrot and Stefan 1993; Theurer et al., 1984), some studies have indicated that air temperatures are the prime determinant of stream temperatures. These studies have based their conclusions on correlation rather than causation (Johnson, 2003). Air and water temperatures are generally well correlated, however correlation does not imply causation. Heat budgets developed to track heat exchange consistently demonstrate that solar radiation is the dominant source of heat energy in stream systems (Johnson, 2004; ODEQ, 2002; Sinokrot and Stefan, 1993). Stream temperature modeling conducted as part of this analysis (described below), confirms that solar radiation is the dominant heat exchange process in the Scott River watershed (Figures 4.1A-D). The analysis also demonstrates that heat exchange from air to water via convection is a minor component of the heat budget.

The conclusion that solar radiation is the dominant source of stream temperature increases is supported by studies that have demonstrated both temperature increases following removal of shade-producing vegetation, and temperature decreases in response to riparian planting. Johnson and Jones (2000) documented temperature increases following shade reductions by timber harvesting and debris flows, followed by temperature reductions as riparian vegetation became re-established. Shade loss caused by debris flows and high waters of the flood of 1997 led to temperature increases in some Klamath National Forest streams (de la Fuente and Elder, 1998). Riparian restoration efforts by the Coos Watershed Association reduced the MWAT of Willanch Creek by 2.8 ^{o}C (6.9 ^{o}F) over a six-year period (Coos Watershed Association, undated). Miner and Godwin (2003) reported similar successes following riparian planting efforts.

4.1.2 Stream Heating Processes Affected by Human Activities in the Scott River Watershed

Regional Water Board staff identified five factors influenced by human activities in the Scott River watershed have affected, or have a potential to affect stream temperatures. The five factors are:

- Stream shade
- Stream flow via changes in groundwater accretion
- Stream flow via surface diversion
- Channel geometry
- Microclimate

4.1.2.1 Stream Shade

Direct solar radiation is the primary factor influencing stream temperatures in summer months. The energy added to a stream from solar radiation far outweighs the energy lost or gained from evaporation or convection (Beschta and others, 1987; Sinokrot and Stefan 1993; Johnson, 2004). Because shade limits the amount of direct solar radiation reaching the water, it provides a direct control on the amount of heat energy the water receives.

Shade is created by vegetation and topography; however, vegetation typically provides more shade than topography. The shade provided to a water body by vegetation, especially riparian vegetation, has a dramatic, beneficial effect on stream temperatures. The removal of vegetation decreases shade, which increases solar radiation levels, which, in turn, increases stream temperatures. Additionally, the removal of vegetation increases ambient air temperatures, can result in bank erosion, and can result in changes to the channel geometry to a wider and shallower stream channel, all of which also increase water temperatures.

4.1.2.2 Groundwater

Ground water accretion affects temperatures in a number of ways. Most importantly, groundwater accretion provides a stream with a cold source of water that dilutes the thermal energy in the stream (advection). This dilution increases a stream’s capacity to assimilate heat. Additionally, groundwater accretion increases the volume of water, which increases the thermal mass and velocity of the water. Thermal mass refers to the ability of a body to resist changes in temperature. Basically, more water heats or cools slower than less water. Increases in velocity reduce the time required to travel a given distance, and thus reduces the time heating and cooling processes can act on the water. These principles are true for any stream, however because the Scott River gains so much of its volume from groundwater accretion in most years (see discussion in section 4.3.1.7), the processes that groundwater accretion influences are particularly effective at limiting stream temperatures.

Water use in Scott Valley is intense. The major human uses of the water are irrigation of alfalfa and other hay crops, irrigation of pasture, watering of livestock, and domestic needs. The great demand for water resulted in the adjudication of water rights in 1980. Unfortunately, the adjudication does not establish minimum instream flows for aquatic life. The US Forest Service does have a junior water right for instream fisheries and recreation flows downstream of Scott Valley, but the requirements are rarely met.

The Scott River Adjudication was the first in California to recognize the linkage between groundwater and surface water. In fact, new legislation was required (resulting in water code section 2500.5) to allow ground water resources to be included in the adjudication.

Unfortunately, the adjudication only recognized a narrow zone of the aquifer as being interconnected with surface water. The interconnected zone is defined in the adjudication as follows (Superior Court of Siskiyou County, 1980):

> Interconnected ground water means all ground water so closely and freely connected with the surface flow of the Scott River that any extraction of such ground water causes a reduction in the surface flow in the Scott River prior to the end of a current irrigation season.

The aquifer characteristics and groundwater-surface water dynamics of Scott Valley are poorly understood. The degree to which water use affects groundwater accretion cannot be determined from the available information. The analysis is complicated by the fact that, while groundwater pumping undoubtedly contributes to a drawn down aquifer, irrigation and leaky ditches must also contribute some amount of recharge.

The Scott River Adjudication allows for irrigators to switch from surface water to interconnected ground water, provided that any new wells are located at least 500 feet from the Scott River, or at the most distant point from the river on the land that overlies the area of interconnected groundwater, whichever is less. The only restriction placed on the use of interconnected groundwater is that the water pumped shall be used for irrigation of crops overlying the "Scott River ground water basin" in amounts reasonable for the acreage irrigated. The adjudication does not address groundwater use outside the interconnected zone.

A human-related factor not related to water use that has negatively affected the water table is the incision of the river channel. In 1938, the US Army Corps of Engineers constructed levees, and straightened and channelized the Scott River throughout the middle part of Scott Valley. Many landowners have subsequently rip-rapped the river banks, which has kept the river channelized. Additionally, the removal of a diversion dam in the mid 1980s resulted in a knick-point that has since migrated upstream and further lowered the channel bed. One effect of these channel changes is that with the stream channel lower, the water table drops faster and further during the dry season. Consequently, the aquifer is unable to store as much water compared to the un-incised channel condition. In essence, the river acts as a drain, and the channel incision makes it a more effective drain. A second effect is that the river does not flood as frequently, which reduces groundwater recharge.

There are a number of issues related to drawdown of the Scott Valley aquifer that do or may affect water quality and stream habitat:

1. Dewatered Channel. This is the most severe impact related to drawdown of the Scott Valley aquifer. In dry years the water table is lower than the bottom of the river channel and

consequently the river water percolates into the aquifer to the point that there is no continuous flow. The Scott River went dry for long stretches in 1924, 1977, 1991, 1994, 2001, 2002, and 2004. Pumping groundwater can contribute to drawdown of the aquifer. However, the river would likely go dry in severe droughts, even without pumping. (Channel dewatering can also be affected by channel aggradation as a result of increased sediment loads.)

2. Temperature Impacts. In normal water years the river is a gaining system. The ground water that enters the Scott River is relatively cold (approximately 58 ^{o}F) and has a cooling effect on the river. The temperature modeling results indicate that the amount of groundwater entering the Scott River has a profound effect on its temperature.

3. Migration Impacts. The depletion of groundwater also affects the ability of adult salmonids to access reaches of the river and tributaries they use for spawning during the fall of dry years. Adult chinook salmon often begin their migration prior to the beginning of the rainy season and before the end of the irrigation season. In dry years, river flows do no rebound even after irrigation ceases. During those dry years, there are insufficient flows to allow the fish to pass some stretches of the river in the canyon downstream of Scott Valley. The Scott River Watershed Council has identified fall flows as a limiting factor affecting salmonids in the Scott River watershed.

4. Riparian Impacts. The rapid lowering of the Scott Valley water table may interrupt the natural succession of riparian tree species and hinder the success of riparian planting projects. Basically, the issue is whether trees can grow roots fast enough to keep up with the drop in water table elevation. Riparian shade is critical for maintenance of natural stream temperatures.

The available data pertaining to ground water conditions in the Scott River mostly consist of a few reports that characterize the aquifer and subsurface sediments in broad terms. The only readily available data that provide a glimpse of recent groundwater conditions are water table measurements at five wells in Scott Valley. Analysis of these data shows that in general drawdown is greater in dry years. The water table measurements for one of the wells are presented in Figure 4.2.

4.1.2.3 Surface Water

Surface water diversions affect stream-heating processes by reducing advection, reducing thermal mass, and increasing travel time. The diversion of water often has a similar but opposite affect of that of groundwater accretion.

4.1.2.4 Channel Geometry

The geometry of a stream channel affects stream temperature processes in a number of ways, at multiple scales. The primary changes in channel geometry that affect stream heating processes are changes in width-to-depth ratios, sinuosity, and streambed complexity (e.g. side channels, deep pools, topographic relief). All of the stream heating processes described in section 4.1.1 are affected by channel geometry to some degree.

A stream's width-to-depth ratio influences stream heating processes by determining the relative proportion of the wetted perimeter in contact with the atmosphere versus the streambed. Water in contact with the streambed exchanges heat via conduction. Conductive heat exchange has a moderating influence, reducing daily temperature fluctuations. Water in contact with the atmosphere exchanges heat via evaporation, convection, solar radiation, and long-wave radiation. Heat exchange from solar radiation far outweighs heat exchange from evaporation, convection, and long-wave radiation, unless the stream is significantly shaded. The net effect of changes in width-to-depth ratios is that streams that are wider and shallower heat and cool faster than streams that are narrower and deeper.

The sinuosity (degree of meandering) of a stream channel can influence stream heating processes in alluvial areas by affecting the amount of intra-gravel flow (hyporheic exchange). In sinuous stream channels, a portion of the water flowing in the channel will pass through the sediments and short-circuit the meanders. The water that passes through the sediments loses heat to the earth through conduction, and re-enters the stream channel cooler than before.

The complexity of the streambed can also influence stream heating processes by affecting the amount of intra-gravel flow, and can lead to the existence of pockets of cold water through stratification of deep pools and hyporheic-fed side channels. Stream channels with greater complexity have deeper pools, more prominent riffles, and back-watered side-channels. The difference in elevation between a pool and riffle determines the amount of water passing through the riffle gravels. Thus, streams with prominent pool-riffle morphology exchange more heat via conduction than flat, simplified stream channels.

4.1.2.5 Microclimate

Microclimate is a phenomenon that results from the separation of air masses. In well-vegetated riparian areas, the mass of air directly over the stream is often effectively separated from the overlying air mass by vegetation, which limits the flow and mixing of air. This separation of air masses can lead to significant differences in air temperature, relative humidity, and wind speed between the near stream air and the overlying air. Removal of riparian vegetation can lead to increased air temperatures, decreased relative humidities, and increased wind speeds.

Air temperature, relative humidity, and wind speed both affect convection and evaporation processes. During warm periods convection typically warms a stream, whereas evaporation cools a stream. The amount of heat exchange that results from convection and evaporation depends on all three microclimate factors. Increased air temperature typically increases the rate of convective and evaporative heat exchange. Decreased relative humidity increases the rate of evaporative heat exchange, but decreases the rate of convective heat exchange. Increased wind speeds increase both evaporation and convection by transporting heat and water vapor away from the stream. It is possible that changes in vegetation inside and/or outside of the riparian area can result in microclimate changes that significantly influence stream temperatures.

4.2 METHODS

4.2.1 Sources of Information

Information used in the development of the temperature analysis came from a variety of sources. Much of the information used in the analysis was developed specifically for the analysis, either by Regional Water Board staff or by entities under contract.

Much of the data used in the development of the temperature model applications was collected during the summers of 2003 and 2004 by Regional Water Board staff. These data included:

- Eighty-nine flow measurements at thirty-two sites,
- Forty-three water temperature records,
- Thirty-four meteorological records,
- Bankfull geometry measurements at twenty sites,
- One hundred fifteen effective shade measurements.

Other supporting data and analysis were developed by the Information Center for the Environment (ICE) at UC Davis, under contract to the Regional Water Board. The analysis and data included a shade model developed for the Scott River watershed, and a Thermal Infrared Radiometry (TIR) survey by Watershed Sciences, LLC, funded through the same contract.

Regional Water Board staff coordinated temperature monitoring activities with the Siskiyou RCD and the USFS. These agencies collected and provided temperature data at thirty sites in the summer of 2003, in addition to a large amount of temperature data from previous years.

Other primary data used in the temperature analysis included habitat typing data provided by the Siskiyou RCD and US Fish and Wildlife Service, flow data obtained from the USGS and

California Department of Water Resources (CDWR), and meteorology data obtained from CDWR.

4.2.2 Approach and Model Selection

The approach used to evaluate and quantify the impacts of human activities in the Scott River and its tributaries relies on the use of computer simulation models. Stream heating processes are inherently complex and non-linear. The degree to which one factor can impact stream temperature is dependent on the state of the other factors involved, and vice versa, thus it is difficult or nearly impossible to quantify the impacts of a single factor without tools that can take into account all the factors at once and evaluate the non-linear relationships involved.

Many computer simulation models have been developed to approximate solutions to the non-linear differential equations that govern stream-heating processes. However, not all stream temperature models are suited for evaluating the particular factors that human activities affect in the Scott River watershed.

To evaluate the five factors identified, Regional Water Board staff selected the Heat Source temperature model. Heat Source is a computer model designed to simulate dynamic mass and heat transfer in streams and rivers. The model is designed to make use of high-resolution spatial data, as well as field measurements. Heat Source calculates a thermal budget at every calculation node along the stream length, and for each time step. The distance between calculation nodes and length of time steps are user-defined. In this analysis, the distance between calculation intervals was 100 meters (328 feet) in all simulations, and the length of time steps varied between one and five minutes. The Heat Source model reports results for every hour of the simulated period. For further information regarding Heat Source, refer to "Analytical Methods for Dynamic Open Channel Heat and Mass Transfer: Methodology for Heat Source Model Version 7.0" (Boyd and Kasper, 2003). The Heat Source documentation is available at http://www.deq.state.or.us/wq/TMDLs/WQAnalTools.htmHeat Source.

The Heat Source model was chosen because it was designed to evaluate the five identified factors (and others) for the purpose of evaluating the effects of human activities. Also, the Heat Source model represents the state of the art in temperature models, has been peer-reviewed, and uses the same approach used to develop temperature TMDLs throughout the Pacific Northwest. Additionally, the Heat Source model has a well described methodology, was designed to make use of high-resolution data, and makes use of a commonly available software platform (Microsoft Excel) that makes it more broadly accessible and user-friendly for other potential users. Other temperature models, such as SNTEMP, Qual2E, and the TVA model, were considered but rejected because none of them simulate the complexity of stream heating processes as well as Heat Source. Also the other models considered have a cumbersome user interface in comparison to Heat Source.

Heat Source requires compilation of a great amount of spatial data. The Oregon Department of Environmental Quality developed the TTools to automate sampling and derivation of spatial data for use in the Heat Source temperature model. Regional Water Board staff also made use of the TTools ArcView extension to organize land cover data and measure channel widths, elevations, and spatial coordinates. TTools also calculates channel gradient, stream aspect, and the angle to the topographic and vegetation horizons. TTools and its calculation methods are described in detail in the Heat Source documentation (Boyd and Kasper, 2003). The parameters required by Heat Source are presented in Table 4.1.

Finally, the RipTopo model (described in Appendix A) was used to evaluate current and potential shade conditions in areas of the Scott River watershed where the Heat Source model was not applied. The RipTopo model uses the same general approach to estimating stream shade as the Shade-a-lator shade model, which is included with the Heat Source model package.

4.2.3 Collection and Use of Stream Temperature and Meteorology Data

Stream temperature and meteorology data were used to develop and calibrate computer simulation models of the selected river stream segments. Stream temperature and meteorology data from multiple sources were used in the source analysis. Regional Water Board staff and contractors, US Forest Service staff, and Siskiyou Resource Conservation District staff collected stream temperature data used in the analysis. Regional Water Board staff collected meteorology data at many locations. Data from the Callahan and Quartz Hill weather stations were also used.

Stream temperature data were specifically used to define boundary conditions and evaluate the accuracy of the models. Data describing air temperature, relative humidity, and wind speed also were used to define local weather conditions required as input to the model. Meteorology from the nearest or most appropriate source was used when site-specific data was unavailable (see Table 4.2).

4.2.4 Collection and Use of Infrared Imagery

The Regional Water Board funded a thermal infrared remote radiometry (TIR) survey of the Scott River and select tributaries (Watershed Sciences, 2004) in support of this study. On July 25 & 26, 2003, Watershed Sciences, LLC conducted aerial TIR surveys of the Scott River, East Fork Scott River, South Fork Scott River, Shackleford Creek, and the lower reaches of Kidder Creek. The imagery was collected using side-by-side video and infrared cameras. The survey yielded temperature measurements of approximately half-meter resolution, in images that captured an area approximately 140 m – 193 m (459ft - 635ft) on the ground, depending on flight altitude. The accuracy of TIR data was better than +/- 0.5^{o}C (0.9^{o}F), based on temperatures measured at the time of the flight. Watershed Sciences subsequently processed the thermal information into longitudinal profiles, a GIS database, and other data products. A complete description of Watershed Sciences' methods, measurement accuracy, and findings are available in their 2004 report (Appendix B).

The survey yielded a tremendous amount of information related to the temperature dynamics of the areas surveyed, as well as high-resolution color imagery. Regional Water Board staff used the thermal data to identify areas of groundwater accretion (the influx of groundwater to a stream), identify springs and seeps, identify stream diversions, calculate tributary flows, and validate the temperature models.

Areas of groundwater accretion are identified in the longitudinal temperature profiles as areas showing cooling or reduced rates of warming. Some examples of this are the pronounced cooling at the downstream end of Scott Valley, and the dip in temperature downstream of Young's dam. Springs and seeps are identifiable in the infrared imagery by their thermal contrast and, in some cases, cold water plumes. For model input, unmeasured tributary flows were often calculated using the mass balance equations shown below.

$$Q_{\text{upstream}} \times T_{\text{upstream}} + Q_{\text{tributary}} \times T_{\text{tributary}} = Q_{\text{downstream}} \times T_{\text{downstream}}$$
$$Q_{\text{upstream}} + Q_{\text{tributary}} = Q_{\text{downstream}}$$

(Q denotes flow and T denotes temperature.)

Given that the downstream flow is equal to the sum of the tributary and upstream flows, and the three temperatures are known from the infrared imagery, only one flow is required to solve for the remaining two values.

4.2.5 Rectification and Use of Color Imagery

Regional Water Board staff used the color imagery collected by Watershed Sciences, LLC to develop a spatial database of stream and riparian attributes. The color images captured during the TIR survey were merged into mosaics, which were then georeferenced, and rectified (aligned with digital maps) using digital orthophoto quads for reference. These rectified images were used to digitize the stream center, wetted widths, and riparian land cover extending 300 feet from the stream. The digitized stream and riparian features were then used to develop information for use in the Heat Source model using the TTools ArcView extension. Examples of rectified imagery are presented in Figures 4.3A –4.3D.

4.2.6 Mapping and Classification of Land Cover

Mapping included digitization of the stream center, stream banks, and land cover up to 300 feet on both sides of the stream. The land cover was digitized to capture visually like land cover types. Land cover types include: seventeen types of native vegetation, pasture, roads, structures, open water, and gravel bars. Vegetation characterizations included type (conifers, deciduous, and mixed), height, and density. Each land cover type was assigned a numeric code describing the species, density, and height of vegetation. Water board staff relied on low-level oblique aerial photos, and species and height measurements collected by staff during field surveys, during the assignment of the numeric codes. Vegetation densities where estimated from the aerial images. Examples of classified land cover are presented in Figures 4.3A –4.3D.

4.2.7 Collection and Use of Flow Data

Regional Water Board staff made 89 flow measurements at 32 sites as part of the data collection for this project. The majority of flow measurements were made using standard velocity-area methods using a tape and velocimeter, however in some cases flows were measured at culverts using a bucket and stopwatch or calculated from the geometry of the culvert and hydraulic principles. Regional Water Board staff also relied on stream gage data provided by USGS and CDWR. The flow data were used to estimate boundary condition flows and estimate rates of ground water accretion using standard mass balance techniques. Measured and estimated flows are presented in Table 4.3

4.2.8 Estimation of Stream Diversions

The Heat Source temperature model accounts for thermal effects of flow diversions. The amount of water diverted at Young's dam was estimated based on information provided by the Scott Valley Irrigation District. Stream diversions were estimated based on the adjudicated water rights associated with a given diversion. Diversions in the East Fork Scott River were estimated based on comparison of upstream and downstream conditions and professional judgment.

4.2.9 Measurement and Estimation of Channel Geometry and Morphology

Regional Water Board staff measured bankfull channel dimensions at twenty locations. These data were collected using a laser rangefinder and digital clinometer. The bankfull cross-sectional areas and widths were plotted against the drainage area for each site to develop relationships of bankfull cross-sectional area to drainage area (Figure 4.4), and bankfull width to drainage area (Figure 4.5). Bankfull channel measurements were used to estimate the channel widths as part of the RipTopo shade modeling (described in Appendix A), and to estimate the potential channel width of the modeled streams.

Modeled stream widths were developed in two ways. Wetted widths corresponding to current conditions were digitized and measured using the rectified color imagery and mapped channel dimensions. Widths were sampled at 100 meter intervals, based on the digitized wetted channel margins, using the TTools ArcView extension. Potential widths were developed as described in section 4.2.10, below.

Dominant particle sizes were estimated from staff observations and limited channel typing information. The information describing dominant particle sizes is used in the Heat Source computational scheme to calculate streambed heat conduction and hyporheic exchange.

4.2.10 Development of Potential Condition Scenarios

Regional Water Board staff have developed depictions of potential shade, flow, and channel geometry for use in evaluating potential stream temperature conditions.

4.2.10.1 Shade

Potential shade estimates were developed through the use of two models. The first model, RipTopo (discussed in Kennedy et al., 2005; attached), was used to estimate current and potential shade conditions in streams throughout the watershed. The second model, Heat Source, was used to evaluate potential shade conditions in the mainstem Scott River, South Fork Scott River, East Fork Scott River, and Cabin Meadows/Houston Creek modeling scenarios. RipTopo evaluates potential shade conditions by calculating a shade value based on mature tree heights of the tree species present, and estimates of channel width based on drainage area. Potential shade conditions in the mainstem Scott River, South Fork Scott River, and East Fork Scott River are based on both the mature height of the tree species historically present, as well as the potential width of the channel. Potential shade estimates developed for the Cabin Meadows/Houston Creek scenarios are based on the assumption that current and potential channel widths are the same.

Regional Water Board staff reviewed aerial photos of relatively undisturbed areas taken in 1944 to evaluate whether predicted potential shade conditions are reasonable. The 1944 aerial photos generally show dense vegetation growing along streams. In many cases the vegetation obscures the streams, providing high levels of shade. Based on these and similar observations of mature vegetation encountered during field surveys, Regional Water Board staff feel that the 1944 aerial photos provide validation of the potential shade conditions predicted by the shade models. It is worth noting that many of the upland areas appear more open than current forest conditions, however.

4.2.10.2 Flow

Potential flow conditions were estimated based on full natural flow, with no diversions. Because of the uncertainty regarding potential groundwater accretion rates, Regional Water Board staff evaluated groundwater accretion at a range of values to understand the magnitude of the effects of groundwater on stream temperatures.

4.2.10.3 Width

Potential channel widths were developed using the bankfull relationships described in Section 4.2.9 and a typical width-to-depth ratio for a C-type stream (24) (Rosgen, 1996). Regional Water Board staff assumed:

- The top width of the potential low flow channel of the Scott River would be half the bankfull width, based on a comparison of the wetted widths measured from imagery captured on July 25th and 26th, 2003, to the bankfull widths predicted by the relationship of bankfull width to drainage area (Figure 4.5).
- The potential channel dimensions of the Scott River upstream of the Scott River canyon correspond to a "C" type channel. The Scott River is currently an "F" type channel in this reach (Quigley, 2003).
- The wetted channel widths of July 25th and 26th, 2003, are representative of the top widths of the low-flow channel.
- The low-flow channel width-to-depth ratios are similar to the bankfull width-to-depth ratios.

4.2.10.4 Sinuosity

A hypothetical depiction of the Scott River was developed to represent the river as it was prior to the straightening that occurred in 1938 (SRWC, 2004). The hypothetical stream channel was developed from Fay Lane to Fort Jones. The purpose of the exercise was to evaluate the effects of channel straightening on stream temperatures. Regional Water Board staff used orthophotos to identify remnants of the channel that existed prior to the straightening. In some areas the former channel was easily identified, but in other areas the former channel was not apparent or many former channels were evident. Consequently, much of the channel was developed based on the judgment of Regional Water Board staff. Although the resulting channel alignment and sinuosity does not precisely depict the historic stream channel, the analysis has value because it defines the magnitude of temperature change that could be expected from a more sinuous channel. The increased sinuosity of the hypothetical channel resulted in an increase in channel length from 31.7 kilometers to 34.4 kilometers.

4.2.10.5 Combined Factors

Regional Water Board staff evaluated the combined effects of individual factors affected by human activities on Scott River temperatures. The magnitudes of stream temperature change related to the individual factors affected by human activities (shade, groundwater accretion, surface diversions, channel geometry) were initially analyzed separately to distinguish the importance of each of the factors. However, it is important to understand how the interactions of the individual factors affect stream temperatures. Regional Water Board staff developed three scenarios to evaluate the interaction of individual factors, and to evaluate the expected benefits of the combination of potential restoration measures under various conditions.

The first scenario is meant to define the temperature regime of the Scott River when all potential conditions are met. The scenario assumes a riparian forest of cottonwood, potential channel widths, potential sinuosity, and no diversions. Rates of groundwater accretion were left as estimated for the July 28 – August 1, 2003 time period due to the uncertainty of potential accretion rates.

The second scenario is meant to define the temperature regime of the Scott River when potential vegetation conditions are achieved and rates of groundwater accretion are increased. The scenario assumes a riparian forest of cottonwood with groundwater accretion rates set as 150% of the rates estimated for the July28 – August 1, 2003 time period. Channel widths, sinuosity, and diversions were left as currently depicted.

The third scenario is meant to define the temperature regime of the Scott River in a dry year when potential vegetation conditions are achieved but groundwater accretion is reduced to 25% of the rates estimated for the July28 – August 1, 2003 time period. The purpose of this scenario is to evaluate whether the water quality standard for temperature could be met solely by the achievement of potential vegetation conditions in dry years.

4.3 MODEL APPLICATIONS

Stream temperature models were developed for the mainstem Scott River, the South Fork Scott River, the East Fork Scott River, and Houston and Cabin Meadows creeks. The details pertaining to the development of individual model applications are presented below.

4.3.1 Scott River Mainstem

The Heat Source temperature model was used to simulate the stream temperatures of the Scott River from Fay Lane (RM 50.2) to the mouth of the river, as shown in Figure 4.6. The tailings reach of the river was mapped but was not included in this model application. The tailings reach was not included because the river goes dry for a large stretch of the tailings reach as river water infiltrates into the subsurface, and the infiltrated river water re-emerges in multiple locations that have not been characterized.

4.3.1.1 Boundary Conditions

The boundary condition locations of the Scott River temperature model are listed in Table 4.2 and shown in Figure 4.6. The upstream boundary is at Fay Lane (RM 50.2). The flow at Fay Lane were estimated based on one or more flow measurements at Fay Lane during each simulation period, with daily flow values adjusted based on the relationship between the flows measured at Fay Lane and the summation of the East and South Fork gage flows. Hourly temperature data collected at the site were used to define temperatures at the upstream boundary.

Boundary conditions were defined for twelve tributaries, as shown in Table 4.2 and shown in Figure 4.6. Flows were estimated based on measurements, comparisons with other nearby streams, and TIR data. Seven of the twelve tributaries had temperature data for the modeled time periods Table 4.2. The temperature of Boulder Creek was estimated to be 1.5 ^{o}C less than the temperature of Canyon Creek, based on comparison of summer temperature data collected in the two creeks from 1995 through 1997. The other tributaries (McCarthy, Big Ferry, Mill, and Franklin Creeks) were characterized using the unaltered temperature records of nearby streams. Given the small magnitude of the tributary flows relative to the mainstem, the model results are insensitive to the temperatures of these tributaries.

4.3.1.2 Channel Geometry and Substrate Representation

The channel geometry and substrate of the Scott River were characterized based on channel mapping, habitat typing data, cross sections, channel type, and observations made by Regional Water Board staff.

The channel widths were developed based on the mapped wetted widths of the river on July 25, 2003, the date of the FLIR survey. The wetted widths were then sampled at 100-meter intervals and recorded in a database using the TTools ArcView 3.2 extension. The decision to map wetted channel widths rather than widths of the near-stream disturbance zone, as described in the Heat Source documentation, was based on the assumption that the wetted widths would provide a better representation of the channel when modeled as a trapezoidal channel. The morphology of the Scott River is generally such that a low-flow channel exists within the larger bankfull channel during the summer months.

The width-to-depth ratios were assigned based on typical ratios for the respective Rosgen channel types (Rosgen, 1996). The river channel in Scott Valley was treated as an "F" type channel and assigned a width-to-depth ratio of 28. The river channel in the canyon area (downstream of the valley) was treated as a "B" type channel and assigned a width-to-depth ratio of 17. Regional Water Board staff assigned Rosgen channel types based on habitat typing surveys conducted by the Siskiyou RCD (2003).

The dominant particle size and embeddedness values, used in the Heat Source model to calculate bed conduction and hyporheic exchange, are based on observations made by Regional Water Board staff and limited substrate information reported in habitat typing data collected by the SRCD and USFWS in the valley and canyon reaches, respectively. The bed particle size and embeddedness values are presented in Figure 4.7.

Stream gradients were calculated for each node based on a 10-meter digital elevation model (DEM) using TTools. A full description of the methodology employed by TTools for the gradient calculation can be found in the Heat Source documentation (Boyd and Kasper, 2003). Stream gradients are presented in Figure 4.8.

The Manning's "n" channel roughness coefficients were the parameters used to calibrate the model. These values were initially approximated based on the values reported in USGS Water Supply Paper 1849 (Barnes, 1967). The values were then adjusted so that width, depths and velocities were similar to measured and observed values, and the amplitude of the calculated diurnal change in stream temperature were similar to the measured values. The final values of Manning's "n" are presented in Figure 4.9.

4.3.1.3 Flow Simulation

Regional Water Board staff developed estimates of tributary inputs, groundwater accretion, and surface water diversions as part of the model development. The hydrologic depiction of the Scott River was developed using a mass balance approach. The methods used to define the flows at tributaries and upstream boundary are described in the boundary conditions section, above.

The groundwater accretion estimates were developed based on measured flows at ten locations distributed throughout the modeled reaches. The change in flow rate between measured points, after subtracting tributary inputs and adding diversion withdrawals, was attributed to groundwater accretion. The measured and estimated flows are presented in Table 4.3; modeled stream flows are presented in Figure 4.10. The estimated rates of groundwater accretion are presented in Figure 4.11. Groundwater accretion was estimated and assigned to two locations, both near the mouth of Canyon Creek, based on TIR data and field observations of fisheries biologists (S. Maurer, personnel communication, 9-23-04, described by McFadin, 2006). In some cases the distribution of the groundwater accretion was estimated based on temperature trends observed in the TIR-derived longitudinal temperature profile.

Surface water diversions were estimated for the Scott Valley Irrigation District (SVID) and Farmer's Ditch diversions. The SVID has a water right that allows for 42 cfs to be diverted from the river. However, the river was flowing less than 42 cfs in both of the modeled time periods. The SVID diversion was estimated as 90% of the flow of the Scott River, based on information provided by the SVID. The Farmer's Ditch diversion is upstream of the reach modeled, but was estimated to account for changes in flow that would occur at the upstream boundary as a result of reduced diversions. The Farmer's Ditch diversion was estimated as the difference between the flow measured at Callahan and the estimated flow at Fay Lane.

The flow routing was modeled using the Muskingum-Cunge method, with a storage factor of 0.2.

4.3.1.4 Shade Simulation

Regional Water Board staff developed estimates of current and potential stream shade as part of the model development. The shade estimates were developed using the Shade-a-lator shade model, which is included with the Heat Source model package, and the TTools pre-processor. The inputs to the Shade-a-lator model are the mapped land cover and associated height and density estimates, and the 10-meter DEM. The Shade-a-lator model calculates shade from both vegetation and topography. A full description of the Shade-a-lator methodology is provided in the Heat Source documentation (Boyd and Kasper, 2003).

The estimates of current shade are based on current near-stream vegetation. The estimated current and potential effective shade values are presented in Figure 4.12. A comparison of measured and modeled shade values is presented in Table 4.4.

The potential near-stream vegetation depiction in the canyon reaches was developed based on the distribution and type of current vegetation. The potential vegetation was represented as the mature height of the current vegetation, with open areas represented as the mature condition of the vegetation surrounding them.

In the Scott Valley, historical changes in the near-stream vegetation distribution have been extreme, thus the current vegetation mapping was not useful for depicting potential vegetation. The potential near-stream vegetation depictions in the Scott Valley reaches were developed based on historical photos, vestigial trees, literature, and an assessment of potential Scott River watershed riparian conditions (Appendix A). The available historical photos, taken in the early 1900s, show a continuous riparian forest bordering the Scott River. In most of the photos the trees appear to be Black Cottonwood, although a photo of the river near Fort Jones indicates the river was bordered by a shorter species, most likely willows. Given the uncertainty, Regional Water Board staff modeled shade for a range of potential vegetation conditions. Regional Water Board staff developed a depiction of potential vegetation conditions that represents the potential riparian tree species height, density, and distribution, based on information contained in the assessment of potential Scott River watershed riparian conditions prepared by UC Davis ICE (Appendix A), and Lytle and Merritt (2004).

4.3.1.5 Meteorological Data

Meteorological conditions were characterized using air temperature data from six sites, relative humidity data from five sites, and wind speed data from three sites, as shown in Table 4.2. These data were distributed along the length of the modeled reaches, as shown in Table 4.5. Solar radiation intensity data from the Quartz Hill weather station was used to estimate cloud cover.

4.3.1.6 Model Calibration and Validation

The first application of the model was developed to represent the stream temperature conditions for the August 27 – September 10, 2003 time period. This time period was chosen because it was the time period with the most complete input and calibration data, and relatively constant flows. Although the Heat Source model represents dynamic mass and heat transfer, the groundwater accretion is represented as a constant, which necessitated a period of relatively constant flow. The model performance for the August 27 – September 10, 2003 time period is detailed in Table 4.6A. Charts of measured and modeled stream temperatures are presented in Appendix C.

The model was calibrated by adjusting values of Manning's n. Manning's n (channel roughness) is routinely determined by solving for the coefficient when all the other hydraulic variables (wetted dimensions, slope, and flow) are known. Because it is not subject to direct measurement (i.e. channel roughness can't be measured, rather the effects of channel roughness are measured), and because it affects both wetted dimensions and travel time, it is a logical calibration parameter. In this analysis, the flows and wetted widths were known and some information describing velocities and depths was available, though they were not measured comprehensively. The remaining hydraulic variables, width-to-depth ratio and Manning's n, were the only missing variables required to describe the hydrodynamics of the river. Regional Water Board staff used the estimates of width-to-depth ratios suggested in the model documentation for the given channel types, for lack of better data. The remaining variable, Manning's n, was first approximated using best professional judgment so that initial model runs could be generated, then the variable was adjusted so that the modeled hydraulic conditions approached the measured hydraulic conditions. Although better results may have been possible by also adjusting the width-to-depth ratios, Regional Water Board staff decided to limit the subjectiveness of the calibration by limiting the calibration to only one parameter.

Once the calibration of the August 27 – September 10 model was complete, a second application of the model was developed for another time period. The second time period was chosen because it coincides with the date of many of the MWATs at sites in the Scott River and it is a relatively constant flow period between two spikes in the season's hydrograph. The model performance for the July 28 – August 1, 2003 time period is detailed in Table 4.6B.

There are differences in input values between the model applications representing the two time periods that go beyond the differences in observed conditions. Adjustments to input values were necessary because of data availability and changes in conditions between modeling periods. The first of these adjustments was in the number of calibration/validation data sets available. The July 28 – August 1 time period coincides with 17 data sets, whereas the August 27 – September 10 time period coincides with 20. Sixteen of the calibration/validation data sets were common to both time periods.

The second difference between the model representations of the two time periods was in the number of tributaries represented. The July 28 – August 1 time period simulates 12 tributaries, whereas the August 27 – September 10 time period simulates 10. The two tributaries, Big Ferry and Franklin Gulch creeks, were not included in the later time period because they had fallen below 1 cfs, an amount considered negligible when the river is flowing at 60 cfs.

The comparison of measured and simulated temperatures indicates that, on average, the model under-predicts temperatures from approximately Fay Lane to Fort Jones, over-predicts temperatures from Fort Jones to the USGS gage, and under-predicts again in the canyon. Upstream of Fort Jones the model results are out of phase with the measured temperatures by about two hours, with the simulated temperatures lagging the measured temperatures. The model results are in phase with the measured temperatures in the area near and below Fort Jones. The model is generally in phase with measured temperatures in the reach between Meamber Bridge and Jones Beach, but the model consistently predicts higher temperatures. Below Canyon Creek, the model results are generally in phase with measured temperatures, but the range of diurnal variation is higher in the simulated temperatures.

The model is out of phase with measured temperatures most likely because of differences between actual and simulated travel times. A discrepancy in travel times could be explained by any of the following factors:

1. Groundwater accretion was assumed to be evenly distributed between sites where flows were measured, which is not likely to be the case in reality.
2. The channel roughness coefficients (Manning's n) are mostly constant in the simulation. In reality the channel roughness would be expected to vary from reach to reach.
3. The width-to-depth ratios are mostly constant in the simulation. In reality the width-to-depth ratio varies from reach to reach.

The reason for the consistent bias at Meamber Creek and the USGS gage is most likely due to uncertainty in the magnitude and extent of groundwater accretion, which is known to be significant in the lowest part of the valley. The differences in measured and simulated temperatures below Canyon Creek may be due to differences between actual and modeled width-to-depth ratios, channel roughness, and Canyon Creek flows. The temperature of the Scott River in the lower canyon reaches is sensitive to the temperature and flow rate of Canyon Creek.

Despite the errors described above, Regional Water Board staff believe the model performance is adequate for evaluating the relative roles of management-related factors. This assessment is supported by the following facts:

1. The model predicts the same trends as seen in the measured temperature data during a wide range of weather, flow, and solar conditions.
2. The mean absolute error for the validation period ranged from 0.5 to 2.4 ^{o}C (0.9 to 4.3 ^{o}F), and averaged 1.1 ^{o}C (2.0 ^{o}F). Average bias of the daily average error for the validation period ranged from –1.9 to 2.1 ^{o}C (3.4 to 3.8 ^{o}F), and averaged -0.2 ^{o}C (-0.36 ^{o}F). The measures of error are similar to results of other stream temperature modeling efforts (Deas et al., 2003; Watercourse Engineering, 2003; ODEQ, 2002).
3. The performance of the model is similar in both time periods, which indicates the model performed consistently.

4.3.1.7 Results and Discussion

Groundwater Flow Scenarios

Regional Water Board staff evaluated the effects of groundwater accretion on Scott River temperatures. The Scott River Adjudication (Superior Court for Siskiyou County, 1980) recognizes the interconnection of groundwater and surface waters. Groundwater is the source of much of the irrigation water used in Scott Valley. Given the interconnectedness of groundwater and surface water, and the prevalent use of groundwater for irrigation, evaluating the effects of groundwater accretion on stream temperatures in the Scott River is necessary for evaluating impacts of management on stream temperature. Unfortunately, the Scott Valley groundwater resource has not been well studied. It is not possible to evaluate the degree to which ground water pumping has affected the rate of groundwater accretion at this time. It is possible, however, to evaluate the degree to which the rate of groundwater accretion affects stream temperatures.

To evaluate the degree to which the rate of groundwater accretion affects Scott River temperatures, Regional Water Board staff simulated Scott River temperatures with varying rates of groundwater accretion. The groundwater accretion rates measured in August of 2003 were used as a baseline condition. Regional Water Board staff varied groundwater accretion from 0% to 200% of the baseline condition in 25% increments. The resulting longitudinal profiles of temperature modeling results quantifying effects of groundwater accretion are shown in Figure 4.13.

The results illustrated in Figure 4.13 indicate that as groundwater accretion is reduced, both the rate of heating and cooling and maximum temperatures of the Scott River increase dramatically. As groundwater accretion decreases, the temperature of the river becomes more responsive to shade and cold tributaries. These results can be explained by the fact that groundwater enters the river at a cold temperature (57-67 ^{o}F), as well as the fact that a reduced rate of groundwater accretion results in a reduction of river flow. As flow volume increases, the rate of heating and cooling decreases. Simply put, more water takes longer to heat. It is logical then that because the majority of Scott River summer flow originates from groundwater, the rate of groundwater accretion greatly affects the total volume of the river, and thus, its rate of heating and cooling.

The results indicate that the temperature of the Scott River is very sensitive to the amount of groundwater entering the river. Given that groundwater is the source of the majority of the water that flows out of Scott Valley, this is not a surprising result. For instance, on August 27, 2003, the flow at Fay Lane was approximately 11 cfs, while at the same time the flow at Jones Beach was 34 cfs. Regional Water Board staff have estimated that tributary flows accounted for 2 cfs, while the rate of surface diversion was 17 cfs. This results in approximately 38 cfs discharged from the Scott Valley aquifer on that day. Although the amount of groundwater entering the river varies over the course of the season, flow measurements indicate that groundwater contributed the majority of the Scott River’s flow at the downstream end of Scott Valley throughout the post-snow melt summer season. These conclusions are supported by the Scott River flow measurements reported in the State Water Resource Control Board’s Report on Water Supply and Use of Water, Scott River Stream System (SWRCB, 1974).

Vegetation Scenarios

Regional Water Board Staff evaluated the effects of solar radiation (energy from the sun) on Scott River temperatures. Studies have confirmed that solar radiation is the single most important factor affecting water temperatures in rivers and streams (see discussion, page 4-2).

The two most common factors that affect the amount of solar radiation reaching a stream are shading by topography (mountains and canyons walls) and vegetation. The stream shade analysis takes into account both factors, and uses effective shade as an inverse surrogate for solar radiation. Effective shade is a measure of the percentage of direct beam solar radiation attenuated and scattered before reaching the ground or stream surface, and takes into account the differences in solar intensity that occur throughout a day.

Given the importance of shade in determining stream temperatures, and the fact that riparian vegetation provides shade, evaluating the effects of riparian vegetation on stream temperatures in the Scott River is necessary for evaluating impacts of management on the Scott River. Regional Water Board staff simulated the effects of riparian vegetation on stream temperatures by evaluating the degree of shading and resulting stream temperatures for a range of potential Scott Valley vegetation conditions. Vegetation conditions in the canyon reach of the river were modeled as the mature height of existing vegetation, except in the no vegetation scenario. The simulated potential riparian vegetation depictions are: no vegetation, willows, cottonwoods, ponderosa pines, and a depiction of potential vegetation conditions that represents the potential riparian tree species height, density, and distribution, based on information contained in the assessment of potential Scott River watershed riparian conditions prepared by UC Davis ICE. The average land cover heights depicted in the potential vegetation scenario for the Scott River mainstem are presented in Figures 4.14A and 4.14B for the left and right banks, respectively.

Figure 4.15 presents the longitudinal profiles of temperature modeling results, which quantify the effects of riparian vegetation on Scott River temperatures. The results indicate that riparian vegetation has great potential for reducing the temperature of the Scott River. All vegetation simulations indicate reductions in stream temperature, with the greatest reductions associated with the tallest vegetation. Table 4.7 presents current and potential 5-day average temperatures at monitored sites along the Scott River. The data indicate that some reaches of the Scott River mainstem would meet the non-core juvenile rearing temperature criteria presented in Table 2.8, given potential vegetation conditions. Although the criteria in Table 2.8 are based on 7-day averages, the values reported in Table 4.7 are comparable to these criteria since the five days modeled (July 28 –August 1, 2003) were the five days of 2003 in which water temperatures were the highest. In addition, these data and the stream temperature differences resulting from current and potential vegetation presented in Figure 4.16 clearly show that current stream conditions are not in compliance with the prohibition against temperature increases greater than 5 ^{o}F, stated in the Water Quality Objective for Temperature.

Surface Water Scenarios

Regional Water Board Staff evaluated the effects of surface water diversions on temperatures in the Scott River watershed. Simulations depicting stream temperatures that result from a range of stream diversion magnitudes were developed for the modeled reaches. The resulting longitudinal profiles of temperature modeling results, which quantify effects of changes in surface water diversions, are presented in Figure 4.17.

The results of the surface diversion analysis indicate that reduction of surface diversions from the Scott River would result in modest temperature decreases, relative to the groundwater and vegetation scenarios. However, it is important to consider the effects of surface water diversions when evaluating the cumulative impacts of human activities on stream temperatures.

Channel Geometry Scenarios

Regional Water Board Staff evaluated the effects that changes in stream channel width and sinuosity have on temperatures of the Scott River. Simulations depicting stream temperatures resulting from a range of channel widths were developed for the modeled reaches.

Figure 4.18 presents longitudinal profiles of temperature modeling results quantifying effects of changes in stream geometry. These results indicate that a reduction in channel widths alone would result in moderate reductions in the temperature of the Scott River. The analysis of the effects of channel straightening on temperatures of the Scott River indicates that the reductions in stream temperature associated with a more sinuous stream channel would not be significant. However, it is important to consider the effects of changes in channel geometry when evaluating the cumulative impacts of human activities on stream temperatures.

Combined Scenarios

Regional Water Board staff evaluated the combined effects of individual impacts of various factors affected by human activities on Scott River temperatures. The longitudinal profiles of temperature modeling results quantifying effects of combined scenarios are presented in Figure 4.19. The results of the combined impacts analysis indicate that much of the Scott River could provide summer habitat for juvenile salmonids in at least some years, and some reaches of the Scott River could provide summer habitat for juvenile salmonids even in drier years, if mature riparian vegetation were present. Additionally, the results clearly demonstrate that water quality standards are not being met.

The analysis clearly shows that mature riparian vegetation in and of itself does not prevent stream heating such that the water quality standard for temperature is met. Without improvements in other factors, such as water use and channel geometry, the beneficial uses of the Scott River will continue to be adversely affected by human activities, and thus the Scott River will not meet the water quality standard for temperature.

Discussion

Of the factors affected by human activities, two of the factors stand out as the most important:

- Shading by riparian vegetation, and
- Groundwater accretion.

These two factors affect stream temperatures differently.

Shade limits the amount of solar radiation reaching the water, and thus provides a direct control on the amount of thermal energy the water receives. The reduction in solar radiation results in a lower equilibrium temperature during the hottest parts of the day (which is why a container placed in direct sunlight will be a higher temperature then an identical container placed in shade).

Ground water accretion affects temperatures in a number of ways. Most importantly, groundwater accretion provides a stream with a cold source of water that dilutes the thermal energy in the stream. This dilution increases a stream’s capacity to assimilate heat. Additionally, groundwater accretion increases the volume of water, which increases the thermal mass and velocity of the water. Thermal mass refers to the ability of a body to resist changes in temperature. Basically, more water heats or cools slower than less water. Increases in velocity reduce the time required to travel a given distance, and thus reduces the time heating and cooling processes can act on the water. These principles are true for any stream, however because the Scott River gains so much of its volume from groundwater accretion in most years (see discussion in section 4.3.1.7), the processes that groundwater accretion influences are particularly effective at limiting stream temperatures.

Although shade and groundwater accretion are the two factors that appear to be the most significant, the other factors (surface water diversions and channel geometry) are not trivial and should be considered when evaluating the cumulative impacts of human activities. Diversions of surface water affect stream-heating processes in much the same way that groundwater accretion does. Diversion of surface water reduces the velocities and thermal mass of a river, which ultimately causes it to heat faster.

Changes in channel geometry affect stream temperatures in multiple ways. Increases in channel widths result in a shallower stream for a given flow condition, which results in more of the water being accessible to solar radiation. Conversely, narrower channels have less of their surface exposed to solar radiation.

4.3.2 South Fork Scott River

4.3.2.1 Boundary Conditions

The boundary condition locations of the South Fork Scott River temperature model are listed in Table 4.2 and shown in Figure 4.6. The upstream boundary is just upstream of the road 40N21Y bridge (RM 5.1). The upstream boundary flows were based on the South Fork at Callahan preliminary gage record and a relationship between the gage record and measured flows (Figure 4.20 presents the relationship of flow at the South Fork Scott River gage to measured flows at the upper model boundary). Hourly temperature data collected at the site were used to define temperatures at the upstream boundary.

Boundary conditions were defined for two tributaries, as shown in Table 4.2 and shown in Figure 4.6. Tributary flows were estimated based on FLIR data (calibration period) and preliminary South Fork gage flow data (validation period). Daily flow values were adjusted based on the change in the South Fork gage record. Temperature data was not available for either of the tributaries. The tributaries were characterized using the temperature data from the upstream boundary.

4.3.2.2 Channel Geometry and Substrate Representation

The channel geometry and substrate of the South Fork Scott River was characterized based on channel type, channel mapping, and observations made by Regional Water Board staff.

The channel widths were developed based on the mapped wetted widths of the river on July 26, 2003, the date of the FLIR survey. The wetted widths were then sampled at 100-meter intervals and recorded in a database using the TTOOLs ArcView 3.2 extension. The decision to map wetted channel widths rather than widths of the near-stream disturbance zone, as described in the Heat Source documentation, was based on the assumption that the wetted widths would provide a better representation of the channel when modeled as a trapezoidal channel. The morphology of the South Fork Scott River is generally such that a low-flow channel exists within the larger bankfull channel during the summer months.

The width-to-depth ratio of the South Fork Scott River stream channel was assigned a value of 24, based on the Rosgen channel type (Rosgen, 1996; Boyd and Kasper, 2003). The entire South Fork Scott river channel was treated as a “C” type channel.

The substrate and embeddedness values assigned to the South Fork Scott River were assigned using best professional judgment. The substrate size was assigned a single value of 96 millimeters for the entire reach, based on observations made by Regional Water Board staff. The embeddedness was assigned a value of zero. Regional Water Board staff have found that the model results are not sensitive to either of these parameters.

Stream gradients were calculated for each node based on a 10-meter digital elevation model (DEM) using TTOOLs. A full description of the methodology employed by TTOOLs for the gradient calculation can be found in the Heat Source documentation (Boyd and Kasper, 2003). Stream gradients are presented in Figure 4.21.

The Manning's "n" channel roughness coefficients was assigned a single value of 0.04 for the entire reach. These values were based on the values reported in USGS Water Supply Paper 1849 (Barnes, 1967). Unlike the mainstem Scott River model application, the South Fork Scott River model required no adjustment of the channel roughness coefficient for calibration.

4.3.2.3 Flow Simulation

Regional Water Board staff developed estimates of tributary inputs and surface water diversions as part of the model development. The hydrologic depiction of the South Fork Scott River was developed using a mass balance approach. The methods used to define the flows at tributaries and upstream boundary is described in the boundary conditions section, above. Groundwater accretion into the South Fork Scott River was assumed to be negligible, based on the confined channel morphology. Two surface water diversions were estimated based on the water rights information. The flow routing was modeled using the Muskingum-Cunge method, with a storage factor of 0.2 (Boyd and Kasper, 2003).

4.3.2.4 Shade Simulation

Regional Water Board staff developed estimates of current and potential stream shade as part of the South Fork Scott River model development. The shade estimates were developed using the Shade-a-lator shade model, which is included with the Heat Source model package, and the TTOOLs pre-processor. The inputs to the Shade-a-lator model are the mapped land cover and associated height and density estimates, and the 10-meter DEM. The Shade-a-lator model calculates shade from both vegetation and topography. A full description of the Shade-a-lator methodology is provided in the Heat Source documentation (Boyd and Kasper, 2003).

Potential shade estimates were developed based on depictions of potential near-stream vegetation. The estimates of current shade are based on current near-stream vegetation. The estimated current and potential effective shade values are presented in Figure 4.22.

The potential near-stream vegetation depiction in the South Fork Scott River was developed based on the distribution and type of current vegetation. The potential vegetation was represented as the mature height of the current vegetation, with open areas represented as the mature condition of the vegetation surrounding them.

4.3.2.5 Meteorological Data

Meteorological conditions were characterized using air temperature data and relative humidity data from two sites, as shown in Table 4.2. Data from the Callahan weather station was used to characterize wind speed. Solar radiation intensity data from the Quartz Hill weather station was used to estimate cloud cover.

4.3.2.6 Model Calibration and Validation

The first application of the model was developed to represent the stream temperature conditions for the July 26 – July 31, 2003 time period. This time period was chosen because it was the time period with the most complete input data, and because it was the time period when the water was the warmest. The model performance for the July 26 – July 31, 2003 time period is detailed in Table 4.8.

Once the calibration of the July 26– July 31, 2003 model was complete, a second application of the model was developed for the August 28 – September 10, 2003 time period. The second time period was chosen because it is late enough in the season that flows and shade were substantially different from the first time period. Unfortunately, there was no tributary flow data corresponding to the second time period. The tributary flows were estimated based on the change in flow between the time periods at the South Fork Scott River gage. The estimated flows are less reliable than those estimated from FLIR data in the first time period. The mean absolute error for the validation period ranged was 1.0 ^{o}C (1.8 ^{o}F). Average bias of the daily average error for the validation period was –1.0 ^{o}C (-1.8 ^{o}F). The model performance for both time periods is presented in Table 4.8 and Appendix C. The measures of error are similar to results of other stream temperature modeling efforts conducted in the basin (Deas et al., 2003; PacifiCorp, 2003; ODEQ, 2002), including those that have been developed as part of adopted TMDLs.

4.3.2.7 Results and Discussion

Vegetation Scenarios

The results of the riparian vegetation analysis, presented in Figure 4.23, show that small (<0.5 ^{o}C) differences in temperature would result from the achievement of potential riparian vegetation conditions in the modeled reach of the South Fork Scott River. These results suggest that riparian vegetation in the modeled reach of the South Fork Scott River is already near the

potential condition, as modeled. Other factors that may explain the similarities are the moderating influence of Boulder Creek and a relatively short travel time.
Surface Water Scenarios

The results of the surface diversion analysis, presented in Figure 4.23, indicate that diversions from the South Fork Scott River result in minimal temperature increases. The minor difference in model temperatures reflect the fact that the amount of water diverted from the South Fork is small relative to the total flow.

Discussion

The results of the analysis indicate that the modeled reach of the South Fork Scott River is near potential conditions, and the impact of surface diversions on stream temperatures is minor when conditions are as they were in the summer of 2003. It is possible that surface diversions could have more of an effect on stream temperatures in dry years when flows are lower. The impact of surface diversions on stream temperatures would increase as flows in the South Fork Scott River decreased.

4.3.3 East Fork Scott River

4.3.3.1 Boundary Conditions

The boundary condition locations of the East Fork Scott River temperature model are listed in Table 4.2 and shown in Figure 4.6. The upstream boundary is just downstream of Houston Creek (RM 14.0). The flow values were based on the East Fork at Callahan preliminary gage record and a relationship between the gage record and measured flows at the upstream model boundary (Figure 4.24). Hourly temperature data collected at the site were used to define temperatures at the upstream boundary.

Boundary conditions were defined for five tributaries, as shown in Table 4.2 and Figure 4.6. Flows were estimated based on FLIR data and preliminary East Fork gage flow data. Daily flow values were adjusted based on the change in the East Fork gage record. Temperature data was not available for any of the tributaries. The tributaries were characterized using the temperature data from a site on Rail Creek. The Rail Creek data was adjusted based on the difference between the FLIR measurement of the tributary and the Rail Creek record. Regional Water Board staff assumed that the difference between the FLIR-derived tributary measurements and the temperature of Rail Creek at the time of the measurement (4:00 pm) represented a reasonable approximation of the daily maximum temperatures difference at the sites. The differences ranged from 1.4 to 4.0 ^{o}C. Synthetic temperature records were then constructed for the five tributaries such that the absolute difference in maximum and minimum stream temperatures was equal to the difference between the FLIR-derived temperature and the temperature of Rail Creek.

4.3.3.2 Channel Geometry and Substrate Representation

The channel geometry and substrate of the East Fork Scott River was characterized based on channel type, channel mapping, and observations made by Regional Water Board staff.

The channel widths were developed based on the mapped wetted widths of the river on July 25, 2003, the date of the FLIR survey. The wetted widths were then sampled at 100-meter intervals and recorded in a database using the TTOOLs ArcView 3.2 extension. The decision to map wetted channel widths rather than widths of the near-stream disturbance zone, as described in the Heat Source documentation, was based on the assumption that the wetted widths would provide a better representation of the channel when modeled as a trapezoidal channel. The morphology of the East Fork Scott River is generally such that a low-flow channel exists within the larger bankfull channel during the summer months.

The width-to-depth ratio of the East Fork Scott River stream channel was assigned a value of 40, based on the professional judgment and observations of Regional Water Board staff, who noted that the East Fork Scott River was very wide and shallow in comparison to other streams.

The substrate and embeddedness values assigned to the East Fork Scott River were assigned using best professional judgment. The substrate size was assigned a single value of 64 millimeters for the entire reach, based on observations made by Regional Water Board staff. The embeddedness was assigned a value of 0. Regional Water Board staff have found that the model results are not sensitive to either of these parameters.

Stream gradients were calculated for each node based on a 10-meter digital elevation model (DEM) using TTOOLs. A full description of the methodology employed by TTOOLs for the gradient calculation can be found in the Heat Source documentation (Boyd and Kasper, 2003). Stream gradients are presented in Figure 4.25.

The Manning’s “n” channel roughness coefficients were assigned a single value of 0.06 for the entire reach. These values were based on the values reported in USGS Water Supply Paper 1849 (Barnes, 1967). Unlike the mainstem Scott River model application, the East Fork Scott River model required no adjustment of the channel roughness coefficient for calibration.

4.3.3.3 Flow Simulation

Regional Water Board staff developed estimates of tributary inputs and surface water diversions as part of the model development. The hydrologic depiction of the East Fork Scott River was

developed using a mass balance approach. The methods used to define the flows at tributaries and upstream boundary are described in the boundary conditions section, above.
Stream flows in the East Fork Scott River are complex. Thermal infrared imagery of the East Fork shows at least thirteen springs scattered along the length of the East Fork of the Scott River, eight of which were represented in the model application (the five remaining springs were identifiable, but deemed negligible). The spring flow rates were estimated using the FLIR data and mass balance techniques described in Section 2.3. The estimated flows ranged from 0.2 – 1.1 cfs. The temperatures of the springs were assigned the accretion temperature calculated by the model. The modeled stream flows of the East Fork Scott River are presented in Figure 4.26.

The East Fork Scott River hydrology reflects the intense irrigation practiced in the basin, in addition to the natural hydrologic complexity. Ten irrigation diversions were accounted for in the model application. Additionally, a number of sites were identified where tailwater (irrigation runoff) was re-entering the river. Water rights information was not helpful for defining diversion amounts because the water rights exceeded the estimated flow of the river. Instead, Regional Water Board staff estimated the rate of diversion by comparing the wetted dimensions of the channel upstream and downstream of the diversion, by estimating the efficiency of gravel dams, and by best professional judgment. Tailwater return flows were not accounted for in the model due to lack of data.

Groundwater accretion was used as a calibration parameter in this analysis. Accretion values were adjusted to ensure the simulated stream did not become dewatered, and to match the trends seen in the infrared data. The modeled groundwater accretion values are shown in Figure 4.27.

The flow routing was modeled using the Muskingum-Cunge method, with a storage factor of 0.2 (Boyd and Kasper, 2003).

4.3.3.4 Shade Simulation

Regional Water Board staff developed estimates of current and potential stream shade as part of the East Fork Scott River model development. The shade estimates were developed using the Shade-a-lator shade model, which is included with the Heat Source model package, and the TTOOLs pre-processor. The inputs to the Shade-a-lator model are the mapped land cover and associated height and density estimates, and the 10-meter DEM. The Shade-a-lator model calculates shade from both vegetation and topography. A full description of the Shade-a-lator methodology is provided in the Heat Source documentation (Boyd and Kasper, 2003).

Potential shade estimates were developed based on depictions of potential near-stream vegetation. The estimates of current shade are based on current near-stream vegetation. The estimated current and potential effective shade values are presented in Figure 4.28. In areas where the natural vegetation type is intact the potential vegetation was represented as the mature height of the current vegetation, with open areas represented as the mature condition of the vegetation surrounding them. In areas that have been converted to pasture, such as the areas upstream of Masterson road, the potential vegetation was simulated as mature Black Cottonwood, based on vestigial stands in the area.

4.3.3.5 Meteorological Data

Meteorological conditions were characterized using air temperature data and relative humidity data from two sites, as shown in Table 4.2. Data from the Callahan weather station was used to characterize wind speed. Solar radiation intensity data from the Quartz Hill weather station was used to estimate cloud cover.

4.3.3.6 Model Calibration and Validation

The East Fork model application was developed to represent the stream temperature conditions for the July 25 – July 31, 2003 time period. This time period was chosen because it was the time period that coincides with the infrared data, and because it was the warmest time period. The infrared data and associated imagery were relied on extensively during the model development and calibration process, due to a lack of on-the-ground data. Because of the complex hydrology of the East Fork Scott River and the paucity of data, a model application was not developed for another time period. The model performance for the July 25– July 31, 2003 time period is detailed in Table 4.9.

The results of the model calibration indicate that the model simulates the trends seen in the infrared and instream data. The error statistics presented in Table 4.9 indicate the model underestimates temperatures at both sites, with site two being underestimated considerably more than site one. The shade estimates that the Shade-a-lator model calculated for the reach between Masterson Road and Highway 3 are relatively high. Regional Water Board were denied access to this reach of the river, and the available oblique aerial photos only cover a small portion of the reach. Given that, the vegetation classification has greater uncertainty. Given the uncertainty associated with the vegetation mapping and the estimated flows and temperatures of the lower tributaries (Mule, Grouse, and Big Mill Creeks) and their great influences on downstream temperatures, it is not surprising that the model has less accuracy at Callahan site two.

4.3.3.7 Results and Discussion

Vegetation Scenarios

The longitudinal profiles of temperature modeling results quantifying effects of vegetation are presented in Figure 4.29. The results of the vegetation analysis indicate that the East Fork Scott River has great potential for reduced temperatures. These results indicate that the restoration of potential vegetation conditions could result in a decrease of daily maximum temperatures in the range of 2-6 ^{o}C, and suggest that current stream conditions may not be in compliance with the 5 ^{o}F limit on increased stream temperatures stated in the Water Quality Objective for Temperature. If temperatures were to decrease by 2-6 ^{o}C, much of the East Fork Scott River would improve substantially, and possibly achieve temperature conditions suitable for salmonid migration. The presence of springs also suggests that there is potential for thermal refugia with temperatures suitable for rearing.

Surface Water Scenarios

The longitudinal profiles of temperature modeling results quantifying effects of stream diversions are presented in Figure 4.29. The results indicate that diversions from the East Fork Scott River result in minimal temperature increases. The minor difference in modeled temperatures may reflect that the East Fork Scott River reaches equilibrium quickly regardless of whether the flows are unimpaired.

Discussion

The East Fork Scott River analysis indicates that temperature conditions could improve substantially if riparian areas were restored to their potential conditions. Although the modeling analysis of the East Fork Scott River presents a macro-scale depiction of temperature conditions, the analysis is not able to adequately evaluate the increase in cold water refugia that would accompany the increase in riparian vegetation near the thirteen springs identified in the TIR data. It is likely that an increase in shade would increase the volume of cold water habitat currently created by the springs.

This analysis does not quantify the effects of changes in tributary temperatures on temperatures of the East Fork Scott River. However, it is clear that tributaries such as Crater, Houston, Grouse, and Big Mill Creeks significantly influence the temperature of the East Fork Scott River. Restoration of potential vegetation conditions in these tributaries may provide additional temperature reductions in the East Fork Scott River.

The East Fork Scott River analysis was developed with much less instream data than the other analyses presented. A lack of data describing the flow rates of diversions, tailwater returns, tributaries and springs has resulted in more uncertainty in the model results. However, although there is more uncertainty associated with the East Fork Scott River model applications, the results are consistent with the findings of the other modeling exercises presented in this report.

4.3.4 Houston/Cabin Meadows Creeks

Regional Water Board staff developed an application of the Heat Source model that encompasses the reach of Houston Creek from its mouth at the East Fork Scott River to Cabin Meadows Creek (1.6 miles), then up Cabin Meadows Creek to the 41N03 road crossing, 2.2 miles upstream of Houston Creek. The approach used to develop the Houston/Cabin Meadows model application differed from the approach used to develop the other model applications due to the resolution of the available imagery.

4.3.4.1 Boundary Conditions

The boundary condition locations of the Houston/Cabin Meadows model application are listed in Table 4.2 and shown in Figure 4.6. The upstream boundary is just downstream of the 41N04 road crossing. The flow values were based on measurements made by Regional Water Board staff. Hourly temperature data collected at the site were used to define temperatures at the upstream boundary.

Boundary conditions were defined for two tributaries (upper Houston and Little Houston Creeks), as shown in Table 4.2 and Figure 4.6. Flows were estimated using the mass balance equations described in Section 2.3.6, based on estimates of upstream flows and temperature data from upstream, downstream, and within the tributaries.

4.3.4.2 Channel Geometry and Substrate Representation

The channel geometry and substrate of the modeled reaches of Houston and Cabin Meadows Creeks were characterized based on channel type, and measurements and observations made by Regional Water Board staff.

The upper half kilometer (RM 4.4 - 4.7) of Cabin Meadows Creek stream channel was represented as a B-type channel, with a width-to-depth ratio of 17. From RM 4.4 to RM 2.1, the channel was represented as an A-type channel, with a width-to-depth ratio of 8. Downstream of RM 2.1 the Cabin Meadows and Houston Creek channels were represented as a B-type channel, with a width-to-depth ratio of 17. These representations of the stream channels were based on gradient and field estimates of the wetted widths and depths.

The Manning's "n" channel roughness coefficients were assigned a value of 0.04 in the B-type channel reaches from RM 4.4 to RM 4.7, 0.2 in the A-type reaches (RM 4.4 to RM 2.1), 0.06 from R 2.1 to RM 1.1 and 0.04 downstream of RM 1.1. The values were assigned based on model performance, gradient, and observations of morphological characteristics.

The wetted channel widths were developed based on the relationship of bankfull width to drainage area described in Section 4.2.9. The approximation of channel widths assumed that wetted channel widths were half the bankfull width, based of field measurements.

The substrate and embeddedness values assigned to the modeled reaches of Houston and Cabin Meadows Creeks were assigned using best professional judgment. The substrate size was assigned a single value of 64 millimeters for the all reaches, based on observations made by Regional Water Board staff. The embeddedness was assigned a value of 0. Regional Water Board staff have found that the model results are not sensitive to either of these parameters.

Stream gradients were calculated for each node based on a 10-meter digital elevation model (DEM) using TTOOLs. A full description of the methodology employed by TTOOLs for the gradient calculation can be found in the Heat Source documentation (Boyd and Kasper, 2003). Stream gradients are presented in Figure 4.30.

4.3.4.3 Flow Simulation

Regional Water Board staff developed estimates of tributary inputs using a mass balance approach. The methods used to define the flows at tributaries and upstream boundary is described in the boundary conditions section, above. Groundwater accretion was approximated for only the upper 0.5 km (0.3 mi) of stream channel, the only reach in an alluvial setting.

4.3.4.4 Shade Simulation

Regional Water Board staff developed estimates of current and potential stream shade for the modeled reaches of Houston and Cabin Meadows Creeks. The shade estimates were developed using the Shade-a-lator shade model, which is included with the Heat Source model package, and the TTOOLs pre-processor. The inputs to the Shade-a-lator model are the mapped land cover and associated height and density estimates, and the 10-meter DEM.

High-resolution imagery was unavailable for the modeled reaches of Houston and Cabin Meadows Creek. Instead, the landcover mapping of the modeled reaches was developed based on digital orthophotos. Because the mapping is based on lower-resolution imagery, the uncertainty of the mapped landcover attributes is greater than in the other model applications.

The density of coniferous trees (primarily Pine and Cedar) in the modeled reaches of Houston and Cabin Meadows Creeks is less than the tree density of coniferous reaches (primarily Douglas Fir) in the other model applications, such as the canyon area of the mainstem Scott River and South Fork Scott River. The difference in tree density is reflective of the drier conditions found in the eastern areas of the watershed. The vegetation density was reduced from 60% to 25% in the higher density coniferous areas and from 30% to 10% in the lower density coniferous areas. These values were determined by comparison of modeled shade results with measured shade values.

4.3.4.5 Meteorological Data

Meteorological conditions were characterized using air temperature data and relative humidity data from five sites, as shown in Table 4.2. Wind speed data collected at the bottom end of the modeled reach was used to characterize wind speed for the entire modeled reach. Solar radiation intensity data from the Quartz Hill weather station was used to estimate cloud cover.

4.3.4.6 Model Calibration and Validation

The Houston/Cabin Meadows model application was developed to represent the stream temperature conditions for the August 2 – August 3, 2004 time period. This time period was chosen because of data availability. These are the only two days of data available for this reach.

The model performance is summarized in Table 4.10 and Appendix C. The results demonstrate that the model accurately predicts temperatures on both an hourly and daily basis. The measures of error are similar or better than results of other stream temperature modeling efforts conducted in the basin (Deas et al., 2003; PacifiCorp, 2003; ODEQ, 2002), including those that have been developed as part of adopted TMDLs. However, the model has not been validated with data from an independent time period.

4.3.4.7 Results and Discussion

Vegetation Scenarios

Regional Water Board staff did not develop a depiction of potential vegetation conditions for the Houston / Cabin Meadows model application. Staff did not prepare such an analysis because the resolution of the available imagery is not sufficient to depict a meaningful representation of current and potential vegetation. Regional Water Board staff traversed a significant portion of the modeled reaches (~ 25-35% of the total length). While traversing these reaches, staff observed large tree stumps near the banks of the creek in many of the reaches, and other reaches that appeared undisturbed. Many of the tree stumps were in locations where standing trees would have provided significant shade. Unfortunately, due to the resolution of the imagery, the distinction between the more and less disturbed areas was difficult or impossible to discern in the 1993 orthophotos.

Surface Water Scenarios

Regional Water Board staff evaluated the effects of stream diversions in the Houston / Cabin Meadows Creek stream system. There are currently no stream diversions in Houston or Cabin Meadows Creek. However, stream diversions were evaluated because other similar streams do have diversions, which can be inferred to have similar temperature impacts as those evaluated in this exercise. Regional Water Board staff simulated the effects of stream diversions by parameterizing the flow at the upstream boundary, in 25% increments. Longitudinal profiles of temperature modeling results quantifying effects of surface water flow are presented in Figure 4.31. The results of the surface diversion analysis indicate that diversions of water from small streams can lead to significant temperature increases. . The results presented in Figure 4.31 indicate that, given a 75% reduction in flow, an increase in temperature of 3 ^{o}C (5.4 ^{o}F) would occur 4.8 kilometers downstream of the simulated diversion. An increase of 3 ^{o}C clearly violates the water quality objective for temperature. A stream with less ambient stream shade would be expected to have more extreme temperature increases. Also, without the cool flows of Houston Creek, the reduction in surface flows would result in greater temperature increases downstream.

Evaluation of Forest Practice Rules Effects on Temperatures

Regional Water Board staff developed hypothetical scenarios in order to evaluate the effectiveness of the California Forest Practice Rules' (FPRs) measures for protecting stream temperatures. The analysis evaluated the effects of changes in both shade and microclimate conditions.

Because the pattern of vegetation in the Houston Creek watershed is relatively sparse, potential vegetation conditions are likely to result in less canopy cover than the minimum canopy retention specified in the FPRs. Also, the more sparse vegetation pattern may not result in a significant microclimate. Because of these considerations, Regional Water Board staff developed hypothetical depictions of mature forest conditions that would be expected in a high-density Douglas Fir-dominated environment, which typically has near-stream microclimates. This approach is meant to evaluate the adequacy of the FPRs in a worst-case scenario. Microclimate changes and/or reductions of riparian shade from timber harvest activities are not an issue in all harvest plans.

Regional Water Board staff developed hypothetical depictions of alterations to near-stream microclimate that could occur as a result of near-stream vegetation removal. The depictions were developed based on the magnitude of microclimate changes as reported in the literature (Bartholow, 2000; Brosofske, 1997; Chen et al., 1993; Chen et al., 1999; Dong et al., 1998;

Ledwith, 1996). Because of the variability reported in the literature, a range of microclimate alterations was evaluated.

Four depictions of meteorological conditions were developed as part of the analysis of microclimate effects on temperature. The depictions were developed by multiplying the measured wind speed and relative humidity data by a constant, and increasing air temperature by adding a constant. The constants used to develop the microclimate analysis are presented in Table 4.11. The depictions and the measured meteorological data,

The Houston Creek watershed naturally has a low vegetation density, which has been further reduced by timber harvesting. The meteorological data collected at the five sites monitored in 2004 (listed in Table 4.2) do not provide a good representation of the meteorological conditions associated with forest-stream microclimates in a more dense forest setting (e.g. Douglas Fir). Accordingly, a depiction of riparian microclimate was developed using the measured meteorological data.

The four depictions are meant to provide a range of possible microclimate alteration. The approach used to parameterize changes in microclimate assumes a constant shift. In reality, increases of air temperatures and wind speeds, and decreases of relative humidity resulting from reductions of riparian vegetation are greater in the mid-day than in the morning and evening. Given the approximate nature of the simulation of microclimate alteration, the results of the microclimate analysis should be interpreted accordingly.

Regional Water Board staff evaluated the temperature effects of riparian buffer requirements for both the standard rules, as well as the “Threatened and Impaired” (T&I) rules. The T&I rules apply to watercourses in planning watersheds where threatened species are present. Watercourses in the Scott River could fall under either of the rule sets, depending on whether the watercourse is in a planning watershed upstream of a barrier to salmonid migration.

The FPR stream canopy requirements for T&I waterbodies differ for class I and class II streams. For class I streams, defined as streams with fish always or seasonally present or streams that provide water for domestic use, foresters are required to retain at least 85 percent stream canopy within 75 feet of the stream, with 65 percent retained in the next 75 feet. Additionally, 25 percent of the existing overstory must be composed of conifer species and the 10 largest diameter conifers along any 330-foot stretch of stream must be retained. For class II streams, defined as streams providing aquatic habitat for nonfish aquatic species, foresters are required to retain 50 percent of the total canopy, with retention of 25 percent of the existing overstory conifer (Ch. 14 CA Code of Regulations, Section 916, available online at: http://www.fire.ca.gov/ResourceManagement/pdf/2005FPRulebook.pdf#page2).

The standard FPR stream canopy requirements allow for riparian canopies to be reduced to 50% for class I and class II streams, with the residual overstory canopy consisting of at least 25% of existing overstory conifers. The width of the canopy is required to be 75 feet to 150 feet for class I streams, and 50 feet to 100 feet for class II streams, depending on the slope of the ground.

The results of the analysis of the T&I rules indicate that a reduction from 95% to 85% canopy would not significantly affect stream temperatures of Houston / Cabin Meadows Creek. However, the results indicate temperature increases of approximately 0.5 ^{o}C may occur when combined with microclimate effects. Diurnal temperature modeling results quantifying effects of CA Forest Practice Rules' threatened and impaired riparian buffer requirements and potential microclimate effects are presented in Figure 4.32.

The results of the analysis of the standard FPR riparian canopy requirements indicate that a reduction from 95% to 50% canopy would significantly affect stream temperatures of Houston / Cabin Meadows Creek. The modeling results indicate temperatures would increase from 0.5 ^{o}C to 1.5 ^{o}C. When microclimate effects are taken into account temperatures may increase an additional 0.5 ^{o}C. Diurnal temperature modeling results quantifying effects of CA Forest Practice Rules' standard riparian buffer requirements and potential microclimate effects are presented in Figure 4.33.

The California Forest Practice Rules allow for reduction of stream canopy, as much as 50 percent in some cases. Although stream canopy and effective shade are different measures of riparian characteristics, effective shade is dependent on stream canopy, thus large reductions of stream canopy result in large reductions in effective shade in many cases. The Basin Plan's water quality objective for temperature states that temperatures of intrastate waters shall not be altered unless it can be shown that such an alteration does not impact beneficial uses. Our analysis of factors affecting stream temperatures has determined that reductions of stream shade cause increases in stream temperature. Therefore, the California Forest Practice Rules do not ensure that water quality objectives set in the Basin Plan will be met.

4.3.5 Conclusions of Model Applications

The analysis of factors affecting the temperature of the Scott River and its tributaries indicate that human activities have resulted in significant increases in temperature in many areas of the watershed, small to modest increases in other areas of the watershed, and that removal of vegetation could cause temperature increases in the future. The primary factor affecting stream temperatures is increased solar radiation resulting from reductions of shade provided by riparian vegetation. Groundwater accretion is also a primary factor affecting stream temperatures in Scott Valley. Diversions of surface water lead to relatively small temperature impacts in the Scott River, but add to the cumulative impacts of human activities and have the potential to significantly affect temperatures in smaller tributaries, where the volume diverted is large relative to the total flow.

The analysis of the effects that alteration of near-stream microclimates have on stream temperatures, while crude, indicates that microclimate alterations have potential to increase stream temperatures. The analysis results indicate that the magnitude of such increases is moderate. However, microclimate impacts may be more significant in some situations, and add to cumulative impacts of human activities.

4.4 TEMPERATURE TMDL AND ALLOCATIONS

This section presents the temperature TMDL and load allocations. The starting point for the analysis is the equation that describes the Total Maximum Daily Load or loading capacity:

$$\text{TMDL} = \Sigma\text{WLAs} + \Sigma\text{LAs} + \text{Natural Background}$$

where Σ = the sum, WLAs = waste load allocations, and LAs = load allocations. Waste load allocations are contributions of a pollutant from point sources while load allocations are contributions from management-related non-point sources.

Figure 4.34 shows the adjusted potential shade and current shade aggregated into cumulative frequency curves for the entire set of stream reaches included in the shade analysis. These curves are analogous to curves such as grain size distribution curves that show the percent of the grain size sample that is finer than a given grain diameter. In this case, the curves show the percent of the stream length in the watershed that is shadier than a given shade value. For instance, currently 50% of the stream length in the watershed has an effective shade index greater than 3.6, whereas the 50% of the stream length in the watershed is estimated to have an adjusted potential effective shade index greater than 6.3. Figure 4.35 presents the same information in a different format. Table 4.12 presents in tabular form the same information as Figures 4.34 and 4.35. The estimated adjusted potential shade conditions expressed in Table 4.12 constitute the temperature TMDL for the Scott River watershed.

4.4.1 Development of Pollutant Load Capacity and Surrogate Measures

Under the TMDL framework, and in this document, identification of the ‘loading capacity’ is a required step. The loading capacity represents the total loading of a pollutant that a water body can assimilate and still meet water quality objectives so as to protect beneficial uses. The water quality objective of concern is the temperature objective, which states that natural receiving water temperatures must be met. The loading capacity provides a reference for calculating the amount of pollutant reduction needed to bring a water body into compliance with standards.

This temperature TMDL is focused on the heat loads that arise from changes in streamside vegetation. Other controllable factors possibly influenced by human activities have been identified (i.e, changes in stream flow, microclimates, and channel geometry), but are not included in the TMDL at this time, due to a lack of information. However, these issues are addressed in the implementation actions described in Chapter 5. Regional Water Board staff expect that channel geometry issues will be resolved through reductions in sediment loads that result from implementation of the sediment TMDL. Temperature impacts that result from changes in microclimates will be addressed in the forthcoming Wetland and Riparian Protection Policy, currently under development. The lack of information related to groundwater and surface water interaction and water use is addressed in the implementation plan. Therefore, this temperature TMDL is based on heat loads that arise from changes in streamside vegetation. The temperature TMDL may require revision as hydrologic information becomes available.

To use the loading capacity that focuses on heat loads that arise from changes streamside vegetation, and to be able to compare it to current conditions, a surrogate measure of loading capacity is proposed. It is possible to relate heat load to effective shade (that shade resulting from topography and vegetation that reduces the heat load reaching a stream) and to relate effective shade to temperature conditions. Effective shade can be readily measured in the field and also can be calculated using mathematical equations. EPA regulations (40 CFR §130.2(i)) allow for the use of other appropriate measures (surrogate measures) to allocate loads for conditions "when the impairment is tied to a pollutant for which a numeric criterion is not possible…" (USEPA, 1998c).

For this temperature TMDL, the loading capacity is expressed as effective shade on the summer solstice. Effective shade is an inverse surrogate for solar radiant energy load. The percentage of effective shade represents a percentage reduction of the possible radiant energy load reaching the streams of the watershed during critical temperature periods. Effective shade is evaluated at summer solstice because it is the date at when the sun is highest in the sky and solar radiation loading is the greatest. The annual maximum stream temperature conditions generally occur about four to five weeks after the solstice.

In this analysis, natural effective shade is estimated as potential effective shade (based on fully mature trees growing along the bankfull channel of the streams) reduced by 10 percent to account for natural disturbances such as fire, windthrow, and earth movements that would reduce the actual riparian area vegetation below the site potential. This modified condition is referred to in this document as adjusted potential effective shade, and is the desired condition that meets the water quality objective for temperature and the TMDL.

There are no point sources of temperature within the Scott River watershed, thus the WLA is zero. Therefore, the TMDL loading capacity is equal to adjusted potential effective shade conditions and the associated solar loading. The TMDL equation becomes:

TMDL = Loading Capacity = Adjusted Potential Effective Shade

The loading capacity estimate uses a GIS model developed as part of the Scott River Temperature TMDL analysis (and described in Kennedy et al., 2005; attached) to approximate shade provided by potential vegetation conditions throughout the watershed. The GIS model also was used to estimate current effective shade conditions. These results were used to calculate adjusted potential effective shade. The difference between current and adjusted potential effective shade is the amount of effective shade increase and reduced solar loading that is required to restore beneficial uses.

4.4.2 Load Allocations

In accordance with EPA regulations, the TMDL (i.e., loading capacity) for a water body is to be allocated among the various sources of the targeted pollutant, with a margin of safety. The sum of the load allocations for individual locations in the watershed is equivalent to the loading capacity for the watershed as a whole. Allocations for point sources are known as wasteload allocations. Those for non-point sources are known as load allocations. There are no known point sources of heat into the Scott River and its tributaries.

The TMDL for temperature for the Scott River and its tributaries is distributed among the non-point sources of heat in the watershed, with a margin of safety. In this case, with the non-point sources being sunlight at the various streamside locations in the watershed, and with effective shade being used as a surrogate for solar energy, the establishment of load allocations equates to the identification of the effective shade requirement for any specific streamside location.

Site-specific potential shade is set as the legally required load allocation for the Scott River Temperature TMDL. The load allocations for this TMDL are the shade provided by topography and potential vegetation conditions at a site with an allowance for natural disturbances such as floods, wind throw, disease, landslides, and fire, and is approximated as adjusted potential shade conditions as described in Section 4.4.1. The results of the shade modeling exercises provide an approximation of potential effective shade conditions at the watershed scale. The adjusted potential effective shade conditions for the East Fork Scott River, South Fork Scott River, and mainstem Scott River were calculated from Shade-a-lator model results. Adjusted potential effective shade conditions for the rest of the stream reaches were calculated from the RipTopo model results. The results should not be used to define load allocations at the site-specific level.

The extent of streams in the Scott River watershed that have the potential to support the COLD beneficial use during the critical time periods was developed based on the perennial designation in the "srfish" stream database, and best professional judgment. The adjusted potential shade estimates are presented as an index, with values ranging from 0 (no shade) to 10 (complete shade). The distribution of adjusted potential shade index values, presented in Figure 4.36, is the TMDL load allocation.

4.5 SYNTHESIS

Based on the insights gained from this analysis, Regional Water Board staff have developed the following opinions and judgments related to stream temperatures of the Scott River and its tributaries.

4.5.1 Mainstem Scott River

The mainstem Scott River has been drastically altered over the past 170 years. During that time the following changes have occurred:

- The beaver population has been dramatically reduced,
- the river has been straightened and levied,
- flows have been diverted,
- the extent and quality of riparian forests has been drastically reduced,
- a number of periods of increased sediment loads have occurred.

All of the historic changes mentioned above have affected the temperature regime. Despite these changes, the mainstem Scott River is an important cold water resource that has great potential to contribute to the recovery of salmonid species.

Efforts to actively restore cold water habitats and reduce stream temperatures should proceed in a manner that takes into account the current hydrological setting. Efforts to re-establish riparian vegetation should begin in areas of high groundwater accretion, where the water table is within reach of the trees' roots. Areas of high groundwater accretion are:

- Downstream of the dredger tailings to approximately Etna Creek.
- From the valley/canyon transition upstream to approximately one-half mile upstream of the Quartz Valley Road bridge.
- Downstream of Kidder Creek an unknown distance (the TIR data indicates groundwater accretion, but accretion was not confirmed with flow measurements).

Efforts to re-establish riparian vegetation outside these areas may be limited by the rate at which the water table elevation drops during the growing season. These areas may not recover until changes in water use and management have occurred.

Efforts to restore floodplain processes in the dredger tailing reach downstream of Callahan should also take into account the great ability for this reach to exchange heat with the alluvial substrate. Thermal infrared data clearly demonstrate the pronounced cooling that occurs in this reach via hyporheic processes. A restoration design that includes side channels and other avenues for hyporheic exchange could create significant thermal refugia. In the intervening period, significant increases in cold water habitat volume could be created by enhancement of the west side channel.

The temperature of the Scott River is affected by groundwater in two ways. First, groundwater accretion directly affects stream temperature by direct addition of cold water, changes in volume, and transit time, as described in section 4.3.1.7. Second, the elevation of groundwater affects the ability of riparian tree species to thrive and reproduce, which indirectly affects stream temperatures by increasing exposure to solar radiation.

The degree to which water use affects the elevation of groundwater is unknown. Although groundwater pumping must affect water table elevations, percolation of irrigated water and leaky conveyance ditches must also partially offset pumping effects. A better understanding of groundwater dynamics is needed for future management of Scott Valley water resources. It may be that the aquifers of Scott Valley represent an opportunity to store more water for all uses. The interaction of groundwater elevation, riparian vegetation, and stream temperatures is clearly an area deserving more study.

4.5.2 Scott River Tributaries

Riparian shade is the most important factor affecting the temperatures of tributaries to the Scott River. The current riparian conditions of Scott River tributaries vary widely, due to differences in past and current management practices. In some areas the vegetation is at or near potential conditions, while in other tributaries riparian vegetation has been nearly eliminated.

Management of riparian areas in timber production zones has greatly improved in recent decades, although room for improvement still exists. The current Forest Practice Rules are not protective of stream temperatures in many situations. In addition, the assessment of the effects of timber activities on stream temperatures during the timber harvest planning process could be improved so that a project's potential for altering stream temperatures could be more reliably evaluated.

Efforts to actively restore cold water habitats and reduce stream temperatures in Scott River tributaries should make use of the results of the shade modeling developed as part of this analysis. The shade modeling results can be used to identify areas that are well below potential conditions. When considered together with other pertinent factors, the RipTopo results could be used to develop a prioritized list of riparian restoration sites.

Debris flows related to road fills, stream crossings, and other management features are another factor affecting stream temperatures that is related to forest management activities. Debris flows often drastically reduce riparian shade for great distances downstream of the initial failure. Management-related debris flows that occurred during the flood of 1997 resulted in tremendous changes to riparian areas throughout the Klamath National Forest, including areas of the Scott River watershed (de la Fuente and Elder, 1998). In the Scott River watershed debris flows devastated riparian areas in Tompkins, Kelsey, and Houston Creeks. Efforts to abate the discharge of sediment will positively affect stream temperatures by reducing the risk of future debris flows.

Cattle grazing practices are an ongoing factor related to increased stream temperatures in some Scott River tributaries, particularly but not only in the eastern half of the watershed. In these areas, unrestricted grazing of riparian areas has resulted in a reduction of the density, succession, and vigor of riparian vegetation. Although past and current management in these areas has had a negative effect on riparian vegetation, management approaches have been developed that use grazing as a tool for managing riparian areas in a way that benefits the riparian vegetation, while increasing the available forage. These management approaches take into account the environmental requirements of the particular riparian species, as well as the behavior of cattle and sheep. Outreach efforts that promote these types of management approaches should be supported and encouraged.

4.6 RECOMMENDATIONS FOR ADDITIONAL STUDY AND FUTURE ACTION

- Reduce uncertainty of vegetation mapping in the East Fork Scott River between Masterson Road and Highway 3.
- Reduce uncertainty of vegetation mapping in the Houston / Cabin Meadows Creek model application.
- Complete the mainstem Scott River model development all the way to the East and South Forks.
- Work with stakeholders to develop and implement a Scott Valley groundwater study.
- Work with stakeholders to develop a list of high priority sites for riparian restoration, based on the Rip Topo results.
- Participate in the development and negotiation of Habitat Conservation Plans to ensure long-term planning efforts conform with water quality standards.
- Develop a strategy for addressing issues related to grazing in riparian areas.

- Support riparian grazing workshops where local range managers and other experts can exchange information on the latest techniques for managing riparian areas in rangelands.
- Work with agencies involved in flood response to identify areas of overlapping regulatory authority and develop coordination protocols.

4.7 MARGINS OF SAFETY AND SEASONAL VARIATION

The Clean Water Act Section 303(d) and the associated regulations at 40 CFR §130.7 require that TMDLs include a margin of safety that takes into account any lack of knowledge concerning the relationship between the pollutant loads and the desired receiving water quality. The margin of safety is often implicitly incorporated into conservative assumptions used in calculating loading capacities, waste load allocations, and load allocations (USEPA, 1991). The margin of safety may also be incorporated explicitly as a separate component in the TMDL equation. For this TMDL analysis, conservative assumptions were made that account for uncertainties in the analysis.

- This report analyzes temperature and sediment separately. Some improvements in stream temperature that may result from reduced sedimentation are not calculated explicitly. Reduced sediment loads could be expected to lead to increased frequency and depth of pools and to reduced wetted channel width/depth ratios. These changes tend to result in lower stream temperatures overall and in more lower temperature pool habitat. These changes are not accounted for in the analysis and provide a margin of safety.

- While the potential shade conditions used to calculate the loading capacity assume that the occurrence of potential vegetation at a site extends to the bankfull channel width, the effective shade curves can be applied to either current channel widths or to projected bankfull widths. Application of the curves to current channel conditions does not account for channel narrowing that may occur as a result of reduced sediment loads. These effects constitute a margin of safety.

- Changes in streamside vegetation toward larger, mature trees will increase the potential for contributions of large woody debris to the streams. Increases in large woody debris benefit stream temperatures and associated cool water habitat by increasing channel complexity, including the number and depth of pools. These changes were not accounted for in the analysis and provide a margin of safety.

With respect to seasonal variations in stream temperatures, the analysis takes the most extreme heating conditions as measured by the 7-day running average of temperatures as constituting a limiting condition for salmonid survival with respect to temperature. Additionally, the analysis evaluated thermal processes during the time of year when the streams are the hottest.

CHAPTER 5. IMPLEMENTATION

Key Points

- Implementation actions are the steps and measures that need to be taken in order to meet the TMDLs, achieve sediment and temperature related water quality objectives, and protect the beneficial uses of water in the Scott River watershed.

- The implementation actions are designed to encourage and build upon on-going, proactive restoration and enhancement efforts, comply with the State Water Board’s Nonpoint Source Policy, and comply with the Regional Water Board’s Sediment TMDL Implementation Policy.

- The implementation actions address:
  - sediment waste discharges;
  - roads at the private, county, and state levels;
  - grading;
  - dredge mining;
  - water temperature and vegetation;
  - water use;
  - flood control and bank stabilization;
  - timber harvest;
  - activities on U.S. Forest Service land;
  - activities on U.S. Bureau of Land Management land;
  - grazing; and
  - cooperation with Siskiyou Resource Conservation District, Scott River Watershed Council, Natural Resources Conservation District, and California Department of Fish and Game.

- The implementation actions rely entirely upon existing authorities. No new authorities are proposed.

- The Regional Water Board shall take appropriate permitting and enforcement actions should any of the implementation actions fail to be implemented or should the implementation actions prove to be inadequate.

The primary goal and purpose of the Scott River TMDL Action Plan is to meet the TMDLs, achieve the sediment and temperature related water quality objectives, and protect the beneficial uses of water in the Scott River watershed. The following chapter describes the steps necessary to ensure that this goal will be achieved.

The first section of this chapter describes specific implementation actions. These actions apply to individual landowners and responsible parties, as well as agencies on the local, state, and federal levels. Organization is by topic or source, and by responsible party where that party addresses multiple topics or sources. This organization mirrors that of the proposed Basin Plan amendment language and is designed to make it easier for a stakeholder to find the implementation actions that apply to the stakeholder’s activities. It is important to note that more than one section may apply.

The second section of this chapter describes the permitting and enforcement actions that the Regional Water Board may take should any of the implementation actions fail to be implemented by the responsible party.

The third section of this chapter describes how the TMDL Action Plan is in compliance with the State *Policy for the Implementation and Enforcement of the Nonpoint Source Pollution Control Program*.

5.1 IMPLEMENTATION ACTIONS

5.1.1 Introduction to Implementation Actions

As mentioned in Section 1.4 of the Introduction Chapter, many individuals, groups, and agencies have been working to restore and enhance fish habitat and water quality in the Scott River watershed. Regional Water Board staff recognize that the proactive efforts of these stakeholders have improved water quality conditions. Staff also recognize that on-the-ground implementation of the Scott River TMDL Action Plan and continued water quality improvement will occur much faster and easier if stakeholders continue their efforts. Therefore, many of the implementation actions described in this section are designed to encourage the continued implementation of on-going watershed restoration and enhancement efforts. For example, the Regional Water Board:

- Encourages parties to address high water temperatures by protecting and restoring riparian vegetation. The Siskiyou Resource Conservation District (SRCD), the Scott River Watershed Council (SRWC), industrial timberland owners, the U.S. Forest Service (USFS), and other proactive stakeholders have already undertaken such actions.
- Encourages water users to develop and implement water conservation practices. The SRCD, SRWC, the California Department of Water Resources, and other proactive stakeholders have already undertaken such actions.
- Encourages parties to address sediment waste discharges from roads and other sources. The SRCD, the SRWC, the French Creek Watershed Advisory Group (WAG), industrial timberland owners, the Five Counties Salmon Conservation Program, the USFWS, and the USFS have already undertaken such actions.

- Suggests the County of Siskiyou use the Five County Salmonid Conservation Program as part of their program for addressing sediment waste discharges from county roads.
- Encourages parties to address sediment waste discharges and elevated water temperatures caused by grazing activities. The SRCD, the SRWC, the USFS, and other proactive stakeholders have already undertaken such actions.
- Will work cooperatively with the National Resources Conservation Service (NRCS), the SRCD, and the SRWC to help provide technical support and information.
- Encourages the SRWC to continue to implement the Strategic Action Plan.
- Will work cooperatively with the CDFG to implement applicable recommendations of the Coho Recovery Strategy.
- Will work cooperatively with the USFWS, USFS and the U.S. Bureau of Land Management (BLM) to build upon the actions these agencies have already taken to fully address sediment waste discharges and elevated water temperatures.

Encouragement may take several forms, including efforts by Regional Water Board staff to work with stakeholders to facilitate the planning and implementation of restoration and enhancement projects, staff providing technical assistance for landowners and stakeholders when such assistance is requested, efforts by staff to make compliance with the Nonpoint Source Policy compatible with restoration and enhancement projects, staff coordinating efforts within the Regional Water Board office to simplify and speed up the permit approval process, and formal recognition by the Regional Water Board of good works that improve water quality in the Scott River watershed.

Although the proactive efforts to restore and enhance water quality in the Scott River watershed are making a difference, it is the responsibility of the Regional Water Board to develop and implement actions that will ensure attainment of the sediment and temperature TMDLs and water quality standards. The Regional Water Board also recognizes that the state Nonpoint Source Policy requires that all nonpoint sources of pollution (including sediment waste discharges and elevated water temperatures) be regulated through prohibitions, permits in the form of waste discharge requirements (WDRs), or waivers of WDRs. Therefore, the following implementation actions are designed to encourage and build upon on-going, proactive restoration and enhancement efforts, comply with the state Nonpoint Source Policy, and – most importantly – ensure that the TMDLs are attained and water quality objectives are achieved.

Several of the implementation actions reflect an adaptive approach that outline the stages of implementation that are expected and the process for fully realizing the actions. For example, the implementation actions relating to Caltrans' storm water program (Section 5.1.5), suction dredge mining (Section 5.1.6), and water use (Section 5.1.8) all include a study program. For each of these implementation actions, a time line for completion of the study program is included.

The following implementation actions rely entirely upon existing authorities. No new authorities are proposed.

5.1.1.1 Prioritization of Implementation Actions

Where reaches of the Scott River and its tributaries are providing suitable freshwater salmonid habitat, including coldwater refugia for coho and other salmonids, protection of these areas should be a priority for restoration efforts. Further discussion with landowners and stakeholders can help determine where restoration efforts are likely to yield the greatest benefit to beneficial uses. Prioritization may be scaled to a sub-watersheds or a stream reach.

5.1.2 Road and Sediment Waste Discharge Implementation Actions for Individual Responsible Parties

This section addresses roads and other miscellaneous sources of sediment waste discharges. Within the Scott River watershed, there are approximately 223 miles of paved roads and approximately 2,468 miles of unpaved roads (see Table 3.4 towards the end of this Staff Report for the mileage of roads at different distances from streams in the watershed). As described in detail in the Sediment Source Analysis (Chapter 3), roads are the source of approximately ten percent of the anthropogenic sediment currently being discharged to the Scott River and its tributaries. Roads discharge sediment through surface erosion, stream crossing failures, gullies, cut and fill failures, and landslides. A road is defined as any vehicle pathway, including, but not limited to, paved roads, dirt roads, gravel roads, public roads and highways, private roads, rural residential roads and driveways, permanent roads, temporary roads, seasonal roads, inactive roads, trunk roads, spur roads, ranch roads, timber roads, skid trails, and landings which are located on or adjacent to a road.

In order to prevent, minimize, and control discharges of sediment waste from roads and other sources to the Scott River and its tributaries, the Regional Water Board shall (1) encourage[1] actions to prevent, minimize, and control road-caused sediment waste discharges; and (2) require the development, submittal, and implementation of Erosion Control Plans and monitoring of sediment waste discharge sites on an as-needed, site-specific basis. Both of these implementation actions are described below. Road-related implementation actions are also addressed in Section 5.1.13, in regards to Scott River Watershed Council; Section 5.1.3, in regards to the County of Siskiyou; and in Section 5.1.4, in regards to the California Department of Transportation.

5.1.2.1 Encouragement of Road-Related Sediment Control Actions

As described in the Sediment Source Analysis (Chapter 3), roads used for timber harvest activities, agricultural purposes, residential access, and other uses within the Scott River watershed are sources of sediment waste discharges. Such roads may be owned by private or public individuals or entities and discharge sediment waste due to improper location, surfacing, drainage, or stream crossing design.

In order to prevent, minimize, and control sediment waste discharges from roads in the Scott River watershed, the Regional Water Board encourages the parties responsible for roads to take

[1] It is important to note that encouragement does not waive or replace any applicable permitting or enforcement requirements under the Clean Water Act or the Porter-Cologne Water Quality Control Act.

the necessary actions to prevent, minimize, and control road-caused sediment waste discharges. Such actions may include the inventory, prioritization, control, monitoring, and adaptive management of sediment waste discharge sites caused by roads. Such actions may also include proper road inspection and maintenance. Inspection and maintenance is important as roads which are not maintained will likely result in chronic discharges of sediment waste.

5.1.2.2 Erosion Control Plans & Monitoring

The Regional Water Board's Executive Officer shall require individual, private responsible parties/dischargers, on an as-needed, site-specific basis, to develop and submit an Erosion Control Plan and a Monitoring Plan. Should discharges or threatened discharges of sediment waste that could negatively affect the quality of waters of the State be identified in an Erosion Control Plan or by other means, dischargers shall be required to implement their Erosion Control Plan and monitor sediment waste discharge sites. Such requirements shall be specified in waste discharge requirements (WDRs), waivers of WDRs, cleanup and abatement orders, or other appropriate permitting or enforcement action(s). Parties are subject to such requirements if they are responsible for discharging or threatening to discharge sediment waste to water bodies in the Scott River watershed.

An Erosion Control Plan shall describe, in detail, sediment waste discharge sites and how and when those sites are to be controlled and monitored. A sediment waste discharge site is an individual, anthropogenic erosion site that is currently discharging or has the potential to discharge sediment waste to waters of the State. An Erosion Control Plan may be required to include any or all of the elements described in the *Guidance for the Development and Implementation of an Erosion Control Plan* (Appendix D).

The Porter-Cologne Water Quality Control Act (California Water Code, Division 7) provides the Regional Water Board with the primary authority for requiring Erosion Control Plans and monitoring. The authority to require dischargers to identify, assess, and monitor sediment waste discharge sites is found in California Water Code (CWC) Section 13267. The authority to require dischargers to control sediment waste discharge sites is found in CWC Section 13304 (pertaining to cleanup and abatement activities) and Section 13260 (pertaining to WDRs). Additionally, the requirements to implement an Erosion Control Plan through WDRs, waivers of WDRs, cleanup and abatement orders, or other appropriate permitting or enforcement action satisfies the requirements of the State *Policy for the Implementation and Enforcement of the Nonpoint Source Pollution Control Program*.

As stated above, any party responsible for a road or source that is discharging or threatening to discharge sediment waste to a water body in the Scott River watershed is potentially subject to the requirement to develop, submit, and implement an Erosion Control Plan and conduct monitoring. However, the Regional Water Board's Executive Officer shall require an Erosion Control Plan and monitoring on an as-needed, site-specific basis.

Within two years of the date that the TMDL Action Plan takes effect, specific criteria shall be developed for determining when an Erosion Control Plan shall be required. However, nothing precludes the Executive Officer from requiring Erosion Control Plans prior to the establishment of the criteria. Until specific criteria are developed, erosion control plan requirements shall be focused on roads and other sediment waste discharge sites that are the greatest threat to water quality. The threat to water quality shall be determined by the impacts of the discharge or threatened discharge on the beneficial uses of the Scott River and its tributaries, and the significance of the discharge, including such factors as volume, percent delivery, and the feasibility and reasonability of control.

It is important to note that Erosion Control Plans are not likely to be required in large numbers until after encouragement efforts have the opportunity to prevent, minimize, and control sediment waste discharges. These efforts include the road-related strategic actions developed by the Scott River Watershed Council, a possible grading ordinance for Siskiyou County, and individual actions by parties responsible for roads. Should encouragement efforts fail to be adequate and effective at preventing, minimizing, and controlling sediment waste discharges, the Regional Water Board shall increase the use of existing authorities and regulatory tools, including increasing the number of Erosion Control Plans required of individual responsible parties/dischargers.

Should a responsible party/discharger be required to develop, submit, and implement an Erosion Control Plan and conduct monitoring, the responsible party/discharger will be notified in writing of the requirements. It is likely that, under the authority of CWC 13267, the responsible party/discharger will first be asked to submit any pertinent information on roads, road management, and sediment waste discharge sites that has already been collected by the responsible party/discharger. Following analysis of this information, the Executive Officer shall determine if further information, in the form of an Erosion Control Plan for example, is required. An Erosion Control Plan will likely not be required if the responsible party/discharger has completed a road management plan and/or erosion control plan that is adequate and effective at preventing, minimizing, and controlling sediment waste discharges. Conversely, if an Erosion Control Plan does not identify discharges that could negatively affect the quality of waters of the State, implementation of the Erosion Control Plan will not be required.

An Erosion Control Plan may be required to include any or all of the elements of an Erosion Control Plan described in the *Guidance for the Development of an Erosion Control Plan* (Appendix D). The primary elements of an Erosion Control Plan will likely include (1) an inventory of existing sediment waste discharge sites, roads, stream crossings, and unstable areas; (2) a priority list; (3) a description of sediment control practices; and (4) a schedule for the control of sediment waste discharge sites. These elements are described in detail in the Guidance. The Guidance also includes information on how sediment waste discharge sites can be prioritized for control and that an inventory should focus on sediment waste discharge sites that discharge at least 1 yd^3 per year or 10 yd^3 over ten years.

The Executive Officer shall specify in writing the required contents of an Erosion Control Plan. This is necessary to tailor an Erosion Control Plan to the unique characteristics of a watershed or a piece of property. For example, in several areas of the Scott River watershed, unstable areas have not be identified as a significant source of sediment waste discharges. Therefore, it is unlikely that an Erosion Control Plan in some parts of the Scott River watershed would be required to include an inventory of unstable areas.

5.1.3 Road Implementation Actions for the California Department of Transportation

The California Department of Transportation (Caltrans) has jurisdiction over two state highways in the Scott River watershed: State Route 3, of which approximately 42 miles are within the watershed, and State Route 96, of which only 0.5 miles are within the watershed (CSU Sacramento, 2005a, CSU Sacramento, 2005b). State roads can be sources of anthropogenic sediment waste discharges due to improper location, surfacing, drainage, or stream crossing design.

The primary mission of Caltrans is to provide the people of California with a safe, efficient intermodal transportation system. This mission involves planning, designing, constructing, and maintaining large-scale transportation facilities, such as freeways, highways, interchanges, bridges, and tunnels.

Discharges of waste from Caltrans' facilities are regulated by the State Water Board under the National Pollutant Discharge Elimination System (NPDES) Permit, Statewide Storm Water Permit, and Waste Discharge Requirements (WDRs) for the State of California, Department of Transportation (Caltrans) (Order No. 99-06-DWQ and NPDES No. CAS000003), which was adopted on July 15, 1999. This permit, and the program to implement the permit, are generally known as the Caltrans Storm Water Program.

The overall goal of the Storm Water Program is to integrate appropriate storm water control activities into ongoing activities, thus making control of storm water pollution a part of Caltrans' normal business practices. As described by Caltrans (2005), components of the Storm Water Program include:

- Storm Water Management Plan (SWMP). Caltrans developed the SWMP to describe the procedures and practices used to reduce the discharge of pollutants to storm drainage systems and receiving waters.

- Annual Report and Regional Workplans. The Annual Report describes the activities that Caltrans has undertaken in the previous fiscal year to implement the SWMP. The Regional Workplans describe the activities that Caltrans Districts will undertake in the next fiscal year to implement the SWMP.

- Monitoring and Best Management Practice (BMP) Development. The purpose is to identify pollutants of concern in storm water runoff from Caltrans facilities and to describe how Caltrans identifies, evaluates, and approves BMPs.

- Public Education.

- Guidance for Design, Construction and Maintenance Activities. Guidance documents have been developed to implement storm water BMPs in the design, construction and maintenance of highway facilities.

In order to address sediment waste discharges caused by Caltrans roads and facilities, Regional Water Board staff shall evaluate the effect of the Caltrans Storm Water Program to determine if it is adequate and effective at preventing, minimizing, and controlling discharges of sediment waste in the North Coast Region, including the Scott River watershed. The evaluation shall be complete within two years of the date the TMDL Action Plan takes effect. If Regional Water Board staff find that the Caltrans Storm Water Program is inadequate, Regional Water Board and State Water Board staff shall develop specific requirements, for State Water Board consideration, to be incorporated into the Caltrans Storm Water Program at the soonest opportunity, or the Regional Water Board shall take other appropriate permitting or enforcement actions.

5.1.4 Road Implementation Actions for the County of Siskiyou

There are approximately 270 miles of county roads in the Scott River watershed, sixty-one of which are unpaved. Roads maintained by the County of Siskiyou are public roads that are not under the jurisdiction of the federal government, the State of California, or incorporated cities. County roads can be sources of anthropogenic sediment waste discharges due to improper location, surfacing, drainage, or stream crossing design.

The Siskiyou County Public Works Department's Road Division is responsible for providing safe and driveable public roadways through road resurfacing, rehabilitation, new construction, and routine maintenance (Siskiyou County, 2005). Routine maintenance includes pothole patching and crack filling of asphalt pavements, grading and dust control of unpaved roads, shoulder maintenance, guardrail repair and replacement, snowplowing of mountain roads, traffic sign maintenance and replacement, pavement striping, bridge inspection and repair, and cleaning and maintenance of drainage structures, such as culverts, catch basins, ditches, and gutters. The budget for county road work is inadequate to cover all the work that needs to be accomplished. Therefore, road work is prioritized in order to insure optimum use of available funds. The high priorities are to provide needed maintenance to protect the investment in existing roads and bridges and to provide for improvements to the safety, capacity, and serviceability of the roads (Siskiyou County, 2005).

The County of Siskiyou has been involved in the Five Counties Salmon Conservation Program, which developed the *County Road Maintenance Manual for Northwest California Watersheds. A Water Quality and Stream Habitat Protection Guide* (Sommarstrom et al., 2001). "The purpose of this manual is to provide a user-friendly, fish-friendly guide for County road maintenance staff as part of each county's mission to provide a safe and open road system for the traveling public" (Sommarstrom et al., 2001, p. iii). Through the Five Counties Salmon Conservation Program, the Siskiyou County Road Division has received training on the manual and sediment control practices designed specifically for county roads. Additionally, Siskiyou County has the opportunity with the Five Counties program to inventory their roads for sediment waste discharge sites. This program includes an inventory methodology, guidance, and a database for storing and analyzing the data.

In order to prevent, minimize, and control discharges of sediment waste caused by county roads, the Regional Water Board and the County shall work together to draft and finalize a Memorandum of Understanding (MOU). The MOU shall be drafted and ready for consideration by the appropriate decision-making body(ies) of the County within two years of the date the Scott River TMDL Action Plan takes effect.

The MOU shall include the following:

- a date for the initiation and completion of an inventory of all sediment waste discharge sites caused by county roads within the Scott River watershed, which can be done with assistance from the Five Counties Salmonid Conservation Program;
- a date for the completion of a priority list of sediment waste discharge sites;
- a date for the completion of a schedule for the repair and control of sediment waste discharge sites;
- a date for the completion of a document describing the sediment control practices to be implemented by the County of Siskiyou to repair and control sediment waste discharge sites, which can be done with assistance from the Five Counties Salmonid Conservation Program;
- a description of the sediment control practices, maintenance practices, and other management measures to be implemented by the County of Siskiyou to prevent future sediment waste discharges, which can be done with assistance from the Five Counties Salmonid Conservation Program;
- a monitoring plan to ensure that the sediment control practices are implemented as proposed and effective at controlling discharges of sediment waste;
- a commitment by the County of Siskiyou to complete the inventory, develop the priority list, develop and implement the schedule, develop and implement sediment control practices, implement the monitoring plan, and conduct adaptive management.

In addition, the Regional Water Board encourages the County to adopt the *County Road Maintenance Manual for Northwest California Watersheds. A Water Quality and Stream Habitat Protection Guide* as County policy.

In developing the MOU, the Regional Water Board shall work with the County to develop time lines that take into consideration county resources and county obligations to provide and maintain safe and driveable county roads.

Through the development, review, and implementation of the MOU, Regional Water Board staff shall determine the appropriate permitting or enforcement actions necessary to prevent, minimize, and control sediment waste discharges and elevated water temperatures caused by county roads in the Scott River watershed. Such actions include, but are not limited to, WDRs, waivers of WDRs, cleanup and abatement orders, or other appropriate permitting or enforcement action.

Should the County fail to or choose not to develop, finalize, or execute a MOU, Regional Water Board staff shall initiate appropriate permitting or enforcement actions on county road work activities in the Scott River watershed, for consideration by the Board, without waiting for cooperative efforts from the County.

5.1.5 Ground Disturbance Implementation Actions for the County of Siskiyou

Sediment waste may be discharged from land that has been improperly graded. Grading activities include excavating, earthwork, road construction, fills and embankments, dredging, diking, and prospecting. Grading ordinances established at the county level are often effective and appropriate means of addressing sediment waste discharges from improperly graded land, including roads. There are several benefits of a county grading ordinance, including improved erosion control, watershed protection, watershed or county-wide consistency, health and safety safeguards, and county-level influence and involvement in such regulation.

The County of Siskiyou currently requires subdivision maps to comply with the Siskiyou County Land Development Manual, including the prevention of sedimentation or damages to off-site property (Siskiyou County Code Sec. 10-4.108). The Land Development Manual (County of Siskiyou, 1975) includes standards and specifications for the construction, repair, or alteration of streets, roadways, alleys, concrete structures, drainage, sewerage, and water supply facilities.

In order to prevent, minimize, and control sediment waste discharges from road construction and maintenance, land disturbance, and grading activities outside of subdivisions in the Scott River watershed, the Regional Water Board encourages the County of Siskiyou to develop a more comprehensive ground disturbance ordinance or equivalent County-enforceable mechanism. The ordinance or mechanism may be specific to the Scott River watershed or county-wide in scope. Should the County fail to develop and adopt an ordinance or mechanism within a two years of the date the Scott River TMDL Action Plan takes effect, and in the absence of a grading ordinance or equivalent mechanism, the Regional Water Board shall use existing authorities and regulatory tools to ensure ground disturbance and grading activities are not discharging sediment waste on an individual, responsible party basis. This may include an increase in the number of Erosion Control Plans (Section 5.1.2.2) or WDRs required of individual responsible parties/dischargers. Should the County of Siskiyou adopt and approve an effective grading ordinance or equivalent mechanism, Regional Water Board staff is likely to develop, for Board consideration, a waiver of WDRs for ground-disturbing activities in the area covered by the ordinance or mechanism.

5.1.6 Dredge Mining Implementation Actions

Current mining activities in the Scott River watershed primarily consist of recreational stream bank mining and suction dredge mining in select tributaries and certain reaches of the mainstem Scott River. Most of these activities take place on USFS land in the lower Scott River watershed (USFS, 2000). According to the USFS (2000, 1997), there are no permitted commercial mining operations on public land in the Scott River watershed. No information could be found regarding commercial mining operations on private land.

Suction dredging is an instream, motorized mining technique that uses a flexible hose to vacuum up river sediment for processing. Once sediments are sorted, the potential gold bearing materials are retained in a sluice while the remainder of the dredge sediments (tailings) are discharged downstream. The discharged tailings generally sort out as instream piles of larger particles that quickly settle close to the dredge and a plume of suspended sediment that is usually transported further downstream.

In regards to the effects of suction dredging on the beneficial uses associated with the cold water fishery, existing research is limited and available literature provides conflicting opinions. Suction dredging operations may cause sediment waste discharges through the following mechanisms (U.S. District Court, 2004):

1. Streambed and bank destabilization resulting from channel excavations and the hand-sorting by divers of cobble too large to pass through the dredge may increase scour and fill in areas previously unaffected by dredging.
2. Changes to surface substrate composition potentially affects fish, macroinvertebrates, and floral components of stream ecosystems. For example, fish eggs and larvae could be buried, and/or potential spawning gravels could become embedded with fine sediment after settling out downstream of dredged areas.
3. Replacement of natural spawning gravels by unstable dredge tailings that salmonids may use for egg deposition.
4. Destruction and/or redistribution of existing spawning riffles.

In the Scott River, field observations showed that only 12 of 372 salmon redds were built on dredge tailings because there is much more natural substrate available for redd construction (Kilgore, unpublished in Harvey and Lisle, 1999). However, Harvey and Lisle state that if natural spawning substrate is limited, redd building could take place on undesirable dredge tailings. In a literature review previous to the latter publication, Harvey and Lisle (1998) postulate that dredging near riffle crests can cause riffle crests to erode, leading to spawning site destabilization and, possibly, upstream pools becoming shallower. The authors also state that dredge tailings are likely to wash away during the first peak flows prior to upstream migration and spawning by salmonids, thus leaving no long-term impacts on salmonid habitat.

In contrast, some researchers theorize that in some watercourses, spawning substrate may be enhanced by suction dredging operations at locations where such substrate is lacking. For example, in reaches where an armor substrate layer exists, favorable spawning gravel may be exposed by mining activities (Kondolf et al., 1991, in Harvey and Lisle, 1998). However, the benefits of instream substrate redistribution from dredging could be negated if any newly exposed spawning substrate is loose and unstable, leaving it prone to washing downstream during the first peak flows prior to salmonid spawning activity. It has also been suggested that the depressions left after suction dredging provide cooler, deep-water habitat that was unavailable before dredging was initiated. Harvey and Lisle suggest that more research is needed regarding the effects of motorized suction dredging activities relative to the redistribution of instream substrates, and the possible instability of dredge tailings that could potentially be used for spawning by salmonids.

The literature suggests that the effects of active dredging on macroinvertebrate populations are also mixed. In a field study in Fortymile River and Resurrection Creek funded by the EPA (Royer et al., 1999), results showed that there are little to no long-term effects to macroinvertebrate populations downstream from gold dredging operations. There were, however, short-term losses of populations of macroinvertebrates at, and for some distance downstream of, dredging activity. Royer et al. showed that after dredging ceased at two sites, macroinvertebrate abundance losses were as high as 97% and taxa richness was reduced by 88%.

However, the abundance and diversity of macroinvertebrates were soon reestablished to levels near that prior to dredging. Royer et al. go on to state that the cumulative effects of multiple dredging operations on instream biota at these sites cannot be fully assessed, and may depend on the number of dredges operating, the efficiency of operations, and the rate and extent of macroinvertebrate re-colonization.

Fine sediment is also carried downstream in suspension during dredging operations. It appears that their is a dearth of scientifically documented information regarding the downstream effects of sediment re-suspension from suction dredging activities in gold-bearing watercourses, such as the Scott River. The cumulative effects of simultaneous multiple dredging operations to the Scott River are largely unknown but should warrant further scrutiny and monitoring (U.S. District Court, 2004; Harvey and Lisle, 1999).

The Karuk Tribe (U.S. District Court, 2004) describes possible impacts to the fishery from suction dredging operations may also occur through one of the following mechanisms not associated with sediment discharges:

1. Entrainment can cause direct and indirect mortality of fish, fish eggs, and other early life stages, particularly of salmonids.
2. Entrainment can cause direct and indirect mortality of benthic macroinvertebrates that are the primary prey species of salmonids.
3. Frightening of adult and juvenile summer steelhead or spring Chinook salmon, possibly inhibiting fish migration.
4. Synergy with existing high stream temperatures and other cumulative watershed effects are increased, further stressing salmonid populations.

According to the limited available literature on the subject, the effects of suction dredging on water quality are not fully known. However, the Rogue River and Siskiyou National Forests in Oregon, operating under the umbrella of the Northwest Forest Plan, determined in an Environmental Impact Statement that such mining activities may cause unavoidable adverse effects to the local resources (USFS, 2001).

In order to address potential impacts from dredge mining, both USFS district offices in the Scott River watershed request a Notice of Intent from dredge applicants. If the Notice of Intent indicates significant surface disturbance from proposed activities, than the USFS requires dredge miners to submit a Plan of Operations. There are a number of laws, regulations, policies, and plans directing the USFS to allow mining, including instream suction dredging operations, on Forest Service lands. In essence, all that is needed to prospect and mine for minerals, such as gold, is the designation and registration of a valid claim under the 1872 Mining Law and, as previously mentioned, the submittal of a Plan of Operations by the mine claimant to the local USFS district office (USFS, 2001). Plans of Operations allow the USFS to track claims and require the miner to remediate any adverse effects caused by their mining activities on USFS lands.

The CDFG is also involved with regulating suction dredge mining activities. The CDFG requires an annually renewable permit that limits suction dredging in the Scott River watershed to the period of time between the fourth Saturday in May and September 30. The permit also restricts equipment, so that the upper size limit of the intake orifice at the end of the flexible hose that vacuums up river sediment is 8 inches (CDFG, 2005).

Currently, the U.S. Army Corps of Engineers is not requiring permits for suction dredge mining activities under Section 404 of the Clean Water Act. Since permits under Section 404 are not required, permits issued by the Regional Water Board under Section 401 of the Clean Water Act are also not required. However, if a proposed project does not require a federal permit, but does involve dredge or fill activities that may result in a discharge to "Waters of the State," the Regional Water Board has the option to regulate the project under the California Water Code in the form of waste discharge requirements (WDRs) or a waiver of WDRs. Currently, the Regional Water Board has not chosen to pursue WDRs for suction dredge mining activities.

In order to prevent, minimize, and control possible discharges of sediment waste, the Regional Water Board shall review laws and regulations that address water quality effects of suction dredge mining and shall investigate the impact of dredge mining activities on sediment and temperature loads in the Scott River watershed. Regional Water Board staff shall investigate the impacts of such activities on sediment redistribution and habitat modification from the re-deposition of larger, more settleable particles; the impacts of fine sediment particles; the impacts on instream biota from multiple plumes of suspended sediment; and the impacts of the day-to-day disturbances of motorized suction dredging. The investigation shall be completed within three years of the date the TMDL Action Plan takes effect. If Regional Water Board staff find that dredge mining activities are discharging deleterious sediment waste and/or causing elevated water temperatures, staff shall propose the regulation of such discharges through appropriate permitting or enforcement actions, including, but not limited to, WDRs or waivers of WDRs.

5.1.7 Implementation Actions to Address Water Temperature and Vegetation that Provides Shade to a Water Body

The Basin Plan contains a temperature water quality objective, which in part states that: “The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses” (NCRWQCB, 2005, p. 3-3.00).

The Basin Plan also states that: “Controllable water quality factors shall conform to the water quality objectives contained [in the Basin Plan]. When other factors result in the degradation of water quality beyond the levels or limits established [in the Basin Plan] as water quality objectives, then controllable factors shall not cause further degradation of water quality. Controllable water quality factors are those actions, conditions, or circumstances resulting from man’s activities that may influence the quality of waters of the State and that may be reasonably controlled” (NCRWQCB, 2005, p. 3-1.00).

As described in the Temperature Source Analysis (Chapter 4), the shade provided to a water body by vegetation, especially riparian vegetation, has a dramatic, beneficial effect on stream temperatures. The removal of vegetation decreases shade, which increases solar radiation levels, which, in turn, increases stream temperatures. Additionally, the removal of vegetation increases ambient air temperatures, can result in bank erosion, and can result in changes to the channel geometry in the form of wider and shallower stream channels, all of which increase water temperatures. Therefore, in order to maintain natural receiving water temperatures, natural shade conditions provided by vegetation must also be maintained. The natural receiving water temperatures are the temperatures that result when the environmental factors that influence stream temperature have not be altered by human activities. In the case of the Scott watershed, a key component of achieving such temperatures is achieving mature riparian forest conditions.

Riparian vegetation also provides other benefits to water quality, such as large woody debris recruitment, contributions to a cooler microclimate, stream bank stability, and food production for macroinvertebrates.

Establishing and maintaining riparian vegetation in support of temperature objectives may lead to consideration of other riparian conditions or functions, including for example channel form and sinuosity, surface water/groundwater connection, and low flow channel and flood plain connectivity. In general, it is expected that restoring or mimicking natural channel processes will lead to channel and riparian conditions that are supportive of water quality attainment, including meeting water quality objectives.

The need to retain vegetation that provides shade to a water body is paramount to attaining the temperature TMDL and temperature-related water quality standards in the Scott River watershed. In order to prevent, minimize, and control elevated water temperatures in the Scott River watershed, the Regional Water Board and staff shall take the following three actions.

First, the Regional Water Board encourages parties responsible for vegetation that provides shade to a water body in the Scott River watershed to preserve and restore such vegetation. This may include planting riparian trees, minimizing the removal of vegetation that provides shade to a water body, and minimizing activities that might suppress the growth of new or existing vegetation (e.g., allowing cattle to eat and trample riparian vegetation). The Regional Water Board also encourages the planting of native, non-invasive plants and understands that the removal of invasive, exotic species may be necessary to improve the long-term health of the riparian ecosystem. Restoration and enhancement projects that cause a short-term reduction in the amount of shade may be acceptable if, in the long-term (perhaps ten years) shade has increased and there is a net beneficial effect on stream temperatures.

Second, the Regional Water Board shall develop and take appropriate permitting and enforcement actions to address the human-caused removal and suppression of vegetation that provides shade to a water body in the Scott River watershed. Permitting actions may include, but are not limited to, general waste discharge requirements (WDRs) or waivers of WDRs for grazing and rangeland activities, farming activities near water bodies, stream bank stabilization activities, and other land uses that may remove and/or suppress vegetation that provides shade to a water body. Should general WDRs be developed, they may apply to the entire North Coast Region or just to the Scott River watershed. The Regional Water Board's Executive Officer shall report to the Board on the status of the preparation and development of appropriate permitting actions within [insert timeline to be determined] years of the date that the TMDL Action Plan takes effect.

Third, the Regional Water Board shall address the removal and suppression of vegetation that provides shade to a water body through the up-coming Stream and Wetland Protection Policy. During the 2004 Triennial Review of the Basin Plan, the Regional Water Board determined that the development of a Stream and Wetland Protection Policy is a high priority. The Policy will be a comprehensive, region-wide riparian policy that will address the importance of shade on instream water temperatures and will potentially propose riparian set-backs and buffer widths. The Policy will likely propose new rules and regulations, and will therefore take the form of an amendment to the Basin Plan. Regional Water Board staff are currently scheduled to develop this Policy by 2007, with funding available through a grant from the U.S. EPA.

The Regional Water Board also encourages and supports the use of conservation easements, land trusts, or similar mechanisms as tools to support the preservation and enhancement of riparian vegetation.

5.1.8 Water Use Implementation Actions

Groundwater and surface water use is intense in the Scott River watershed, particularly in the Scott Valley. All surface water rights in the Scott River watershed above the USGS gage station and groundwater within a delineated interconnected groundwater area are adjudicated. There are three adjudications in the Scott River watershed, the largest of which, the Scott River Adjudication, was established by a decree of the Superior Court of Siskiyou County (1980), based on findings and determinations by the State Water Board and its Division of Water Rights. The Scott River Adjudication was initiated by stakeholders in the watershed.

Table 5.1
Water Rights Adjudications

Adjudication	Year	Decree #	Approx. # of Water Rights Holders
Shackleford Creek	1950	13775	45
French Creek	1958	14478	50
Scott River	1980	30662	680

Groundwater and surface water use in the Scott River watershed has a significant effect on stream temperatures. As detailed in the Temperature Source Analysis (Chapter 4), changes in groundwater accretion and instream flows in the Scott River and its tributaries affect water temperatures. Groundwater accretion provides a stream with a source of cold water that dilutes the thermal energy in the stream, which increases a stream's capacity to assimilate heat. Additionally, groundwater accretion increases the volume of water, which increases the thermal mass and velocity of the water. In the mainstem Scott River for example, as groundwater accretion is reduced, both the rate of heating and cooling and the maximum water temperatures increase dramatically. As groundwater accretion decreases, the temperature of the river becomes more responsive to shade and cold tributaries. Surface water diversions also impact stream temperatures - by reducing the velocity and thermal mass of a river which ultimately causes it to heat faster. Beneficial uses associated with the cold water fishery may not be achieved and protected without addressing these issues.

5.1.8.1 Water Conservation Implementation Actions

Water conservation practices implemented by water users throughout the Scott River watershed can be an effective way of increasing groundwater accretion and instream flows in the Scott River and its tributaries. Water conservation practices include watering at night, soil moisture gauging, and tail-water reuse, groundwater percolation, and storage (USEPA, 2003b).

In order to prevent, minimize, and control elevated water temperatures in the Scott River and its tributaries, the Regional Water Board shall encourage water users to develop and implement water conservation practices. However, it is possible that, under the current structure of the Scott River Adjudication, simply saving water from one or more users may not result in benefits to water quality because other water right holders may divert more water if more water is available. Water conservation should be watershed-wide to be the most effective. Therefore, more study is needed, as discussed in the following section.

5.1.8.2 Water Use Implementation Actions

Although the Temperature Source Analysis found that changes in groundwater accretion and surface water flow can have a deleterious effect on stream temperatures and the beneficial uses associated with the cold water fishery, [2] the analysis was not sufficient to determine whether groundwater use has caused a decrease in groundwater accretion rates. Is groundwater pumping and use affecting accretion rates? If yes, by how much? The analysis also did not indicate how surface water use is affecting groundwater accretion rates. Is water from leaking surface water diversion ditches infiltrating back into the groundwater aquifer? If yes, by how much?

Therefore, the Regional Water Board has determined that additional research must be conducted to study the connection between groundwater and surface water in the Scott River watershed, the impacts of groundwater use on surface flow and the beneficial uses associated with the cold water fishery, and the impacts of groundwater levels on the health of riparian vegetation. The study should consider groundwater that is located both inside and outside of the interconnected groundwater area delineated in the Scott River Adjudication (Superior Court of Siskiyou County, 1980) and the amount of water transpired by trees and other riparian vegetation. Should the study find deleterious impacts to beneficial uses, then the study should also identify potential solutions including mitigation measures and changes to management practices.

The Regional Water Board requests that the County of Siskiyou, in cooperation with the Quartz Valley Indian Community, Siskiyou Resource Conservation District (SRCD), and other appropriate stakeholders, conduct the above mentioned study. Regional Water Board staff have determined that working with the County and other stakeholders will be an effective means of conducting the study mentioned above, especially in the Scott Valley where existing forward momentum exists and stakeholders have demonstrated through past efforts their willingness to restore and enhance the Scott River and its tributaries. Additionally, as stated by County Supervisor Armstrong, “The County of Siskiyou intends to retain jurisdiction of its groundwater resources under its primary police powers to protect the public health, safety and morals of its citizens” (Armstrong, 2005, p. 6). The County has also instituted community dialogues and ad hoc workshops to offer assistance regarding possible strategies and objectives for developing groundwater management plans (Armstrong, 2005).

Should the County determine that it and its stakeholders are able to commit to conducting the above mentioned study, the County, in coordination with other appropriate stakeholders shall develop a detailed study plan within one year from the date the Scott River TMDL Action Plan takes effects. The study plan shall include: (1) a description of the study’s goals and objectives; (2) data collection methods and procedures; (3) the general locations of data collection sites; (4) data analysis methods and procedures; (5) quality control and quality assurance protocols; (6) the parties responsible for data collection, data analysis, and reporting; (7) timelines and due dates for data collection, data analysis, and reporting; (8) financial resources to be used; and

[2] The beneficial uses associated with the cold water salmonid fishery in the Scott River watershed include the Cold Freshwater Habitat (COLD); Commercial or Sport Fishing (COMM); Rare, Threatened, and Endangered Species (RARE); Migration of Aquatic Organisms (MIGR); and the Spawning, Reproduction, or Endangered Species (SPWN) beneficial uses.

(9) provisions for adaptive change to the study plan and to the study based on additional study data and results, as they are available.

The Scott River Watershed Council (SRWC) is also addressing groundwater issues in the Scott River watershed. To the extent possible, Regional Water Board staff hope these efforts can dove-tail with the above mentioned study. Cooperation and collaboration will likely greatly increase the effectiveness of all these efforts, reduce duplication, reduce any inconvenience landowners may experience, and produce a better product.

Should the County not succeed in conducting a groundwater study, the Regional Water Board would recommend and request the State Water Board and its Division of Water Rights perform an appropriate study and act in accordance with the results of the study to protect and restore the instream beneficial uses of the Scott River and its tributaries, with particular focus on those beneficial uses associated with the cold water fishery. Depending on the findings of the research, it may be appropriate for the State Water Board to ensure changes be made in how water is used in the Scott River watershed. For example, it may be appropriate to change how existing water rights are managed, perhaps through the employment of a water master. It may be appropriate to develop a requirement or target condition for the elevation of groundwater levels at key locations in the watershed. Such a requirement or target could vary depending on ambient groundwater conditions at the start of the irrigation season and/or precipitation from the previous winter. It may also be appropriate for the State Water Board to consider seeking modifications of the three adjudications in the watershed, to consider conducting proceedings under the public trust doctrine, and/or to consider conducting proceedings under the waste and unreasonable use provisions of the California Constitution and the California Water Code.

5.1.9 Flood Control and Bank Stabilization Implementation Actions

Since the 1930s, extensive flood control structures have been built along the mainstem Scott River and the lower reaches of several tributaries. As stated in the Strategic Action Plan:

> "Following a serious flood in the winter of 1937-38, Siskiyou County requested the U.S. Army Corps of Engineers to 'clear the rivers throughout Scott Valley of debris from flooding.' This work began in August 1938, and included constructing flood levees along the middle channel near Black Bridge (Etna *Western Sentinel*, 8/10/38). The Corps' 'debris clearing' also removed much of the remaining riparian vegetation through the middle of the valley (Lewis, personal communication). Aerial photos of the river from 1944 reveal little or no vegetation along the Scott River's banks" (SRWC, 2004, p. 5-7).

Additionally, as a result of a series of damaging floods from 1940 to 1974, earthen flood control levees were built along lower Etna, Kidder, and Moffett Creeks. Permanent bank stabilization structures were also designed and tested by the U.S. Soil Conservation Service (now the NRCS). Large rock structures proved to be the most flood-proof and, as a result, rock riprap has been placed along much of the Scott River and its tributaries to prevent the loss of farmland (SRWC, 2004).

The Corps and the NRCS do not retain jurisdiction or ownership over these levees and flood control structures. The responsible parties are often the owners of the property on which the flood control structures are located.

As stated earlier, the removal of vegetation decreases shade which increases solar radiation. Many of the existing flood control and bank stabilization structures in place in the Scott River watershed have caused or prevented abatement of elevated water temperatures, both cumulatively and on an individual project basis, through the removal and suppression of vegetation. First, the removal of vegetation for the installation of flood control structures often results in elevated water temperatures. Second, the presence of riprap and other hard surfaces along a stream bank can suppress vegetation and the establishment of potential vegetation conditions. Third, flood control and bank stabilization projects can change the geomorphology of a stream channel so that downcutting occurs. As the level of the stream channel drops, the level of the water table also drops. When the water table falls below the root zone of existing vegetation, vegetation survivability is reduced. Fourth, emergency responses after major floods may not support the reestablishment of riparian vegetation or of channel conditions supportive of the establishment and persistence of riparian vegetation.

It is important to note that flood control and bank stabilization projects can be done in a manner that does not result in elevated water temperatures. For example, a bank stabilization project that incorporates willows and other riparian vegetation can provide both bank stability and shade. Flood control and bank stabilization projects can also significantly modify the morphology of the channel. Results of models runs indicate that a reduction in channel widths along would result in moderate reductions in water temperatures in the mainstem Scott River (see Section 4.3.1.7).

In order to prevent, minimize, and control elevated water temperatures due to flood control and bank stabilization projects in the Scott River watershed, the Regional Water Board shall take the following actions. First, Regional Water Board staff shall encourage[3] parties responsible for levees and other flood control structures to plant and restore stream banks on and around existing flood control structures. Second, the Regional Board proposes an inter-agency working group to address issues of standards and protocols for responding to post-flood emergency response issues, as a means of identifying regulatory issues and resolving them prior to a flood emergency. Third, the Regional Water Board shall rely on existing authorities and regulatory tools, such as the 401 Water Quality Certification program,[4] to ensure that future flood control and bank stabilization activities in the Scott River watershed do not remove or suppress

[3] It is important to note that encouragement does not waive or replace any applicable permitting or enforcement requirements under the Clean Water Act or the Porter-Cologne Water Quality Control Act.

[4] The 401 Water Quality Certification program is authorized by Section 401 of the federal Clean Water Act. Under this program, anyone proposing to conduct a project that requires a federal permit or involves dredge or fill activities that may result in a discharge to U.S. surface waters and/or "Waters of the State" are required to obtain a 401 Certification and/or Waste Discharge Requirements from the Regional Water Board, verifying that the project activities will comply with state water quality standards. The most common federal permit for dredge and fill activities is a CWA Section 404 permit issued by the Army Corps of Engineers. Additionally, if a proposed project does not require a federal permit, but does involve dredge or fill activities that may result in a discharge to "Waters of the State," the Regional Water Board has the option to regulate the project under the State Porter-Cologne Water Quality Control Act in the form of Waste Discharge Requirements or a Waiver of Waste Discharge Requirements.

vegetation that provides shade to a water body and minimize changes in channel morphology that could increase water temperatures.

5.1.10 Timber Harvest Implementation Actions

As described in detail in the Sediment Source Analysis (Chapter 3), timber harvest activities discharge approximately 24% of the anthropogenic sediment currently being discharged to the Scott River and its tributaries (7% from harvest-related landslides and 17% from harvest-related small discrete streamside features). Current timber harvest activities discharge smaller volumes of sediment waste than past practices.

Timber harvest activities are defined as commercial and non-commercial activities relating to forest management and timberland conversions. These activities include the cutting or removal of both timber and other solid wood forest products, including Christmas trees. These activities include, but are not limited to, construction, reconstruction and maintenance of roads, fuel breaks, firebreaks, watercourse crossings, landings, skid trails, or beds for the falling of trees; fire hazard abatement and fuel reduction activities; burned area rehabilitation; and site preparation that involves disturbance of soil or burning of vegetation following timber harvesting activities; but excluding preparatory tree marking, surveying, or road flagging.

In order to prevent, minimize, and control sediment waste discharges and elevated water temperatures caused by timber harvest activities in the Scott River watershed, the Regional Water Board shall use existing permitting and enforcement tools, such as the timber harvest project approval process and the timber harvest general waste discharge requirements (WDRs) and waivers of WDRs. Additionally, the Regional Water Board shall coordinate efforts through habitat conservation plans and work with other agencies and organizations that are actively addressing water quality issues. These actions are described in detail below.

5.1.10.1 Timber Harvest Project Approval Process

The Regional Water Board, the California Department of Forestry and Fire Protection (CDF), and the Board of Forestry and Fire Protection all have direct authority and responsibility to oversee timber harvest activities on private and state-owned lands in California under the Z'Berg-Nejedley Forest Practice Act and the California Environmental Quality Act (CEQA). The Regional Water Board is active in the review of timber harvest plans (THPs), Non-Industrial Timber Management Plans (NTMPs), and other timber harvest projects throughout the North Coast Region.

The CDF and the State Water Resources Control Board (State Water Board) entered into a Management Agency Agreement (MAA) in 1987 to oversee water quality protection on timber harvest operations on non-federal lands in California. Under the MAA, the Board of Forestry and CDF are designated as the primary management agencies for timber harvest activities. However, as of 2003 under Senate Bill 810, a THP may not be approved if the Regional Water Board finds that the proposed timber harvest operations will result in (1) a discharge to a water body impaired by sediment or (2) in a violation of the Basin Plan.

Regional Water Board staff perform the following activities in relation to the timber harvest project review process: pre-harvest, active and post-harvest inspections; review team meetings; Habitat Conservation Plan/Sustained Yield Plan review; watershed analysis; stream monitoring; CDF and Board of Forestry meeting attendance; U.S. Forest Service meetings and review; enforcement and complaints; hillside vineyard conversions, and use of Senate Bill 810 authority.

In order to prevent, minimize, and control sediment waste discharges and elevated water temperatures in the Scott River watershed, the Regional Water Board shall continue to use existing permitting and enforcement tools to regulate discharges from timber harvest activities, including, but not limited to, cooperation with, and participation in, the California Department of Forestry and Fire Protection's timber harvest project approval process.

5.1.10.2 Timber Harvest General Waste Discharge Requirements and Waivers

Waste discharge requirements are authorized in Division 7, Article 4 of the California Water Code. Section 13260 of the California Water Code states that persons discharging or proposing to discharge waste that could affect the quality of waters of the State, other than to community sewer systems, shall file a report of waste discharge. WDRs may take the form of individual or project-specific WDRs, watershed-wide WDRs, general WDRs, or waivers of WDRs.

In order to prevent, minimize, and control sediment waste discharges and elevated water temperatures from timber harvest activities on private and public lands in the Scott River watershed, the Regional Water Board shall continue to use WDRs, general WDRs, and waivers of WDRs to regulate timber harvest activities. The following two sections describe how WDRs and waivers are used on private versus public land.

Timber Harvest Activities on Private (Non-Federal) Lands

In 2004, to regulate the discharge of waste from timber harvest activities on private lands, the Regional Water Board adopted the Categorical Waiver of Report of Waste Discharge (Order R1-2004-0016) and the General Waste Discharge Requirements (Order R1-2004-0030) for Timber Harvest Activities in the North Coast Region. Both the Categorical Waiver and the General WDR program use the CDF timber-harvest, functional equivalent review process for THPs and NTMPs to ensure compliance with the California Environmental Quality Act.

Table 5.2
Waiver Categories

Waiver Category A	Fire safe projects.
Waiver Category B	Emergencies and exemption projects.
Waiver Category C	Projects in conformance with adopted TMDL Action Plans.
Waiver Category D	Modified THPs.
Waiver Category E	NTMPs with Erosion Control Plans.
Waiver Category F	Timber harvest activities that meet specific eligibility criteria.

The Categorical Waiver (R1-2004-0016) waives the requirement to submit a Report of Waste Discharge (ROWD), annual fee, and inspection and reporting requirements for a specific set of timber harvest activities, including fire-safe projects, exemption and emergency notices, projects in conformance with Regional Water Board adopted TMDL Action Plans, modified THPs, NTMPs with Erosion Control Plans, and THPs that meet specific eligibility criteria. These waiver categories are summarized in Table 5.2. Although the

Categorical Waiver specifically lists such projects as eligible for the waiver, timber harvest activities in the Scott River watershed are not eligible for the waiver under Category C simply through the adoption of this TMDL Action Plan. In other words, Categorical Waiver C does not apply to timber harvest activities in the Scott River watershed. This is due to the fact that Categorical Waiver C is based on the assumption, as discussed in the Initial Study (NCRWQCB, 2004), that timber harvest activities in conformance with an adopted TMDL Action Plan would be subject to criteria and requirements of that TMDL Action Plan, including targets or goals to ensure recovery and restoration of instream biological resources, prescriptions to address geologic stability, and prescriptions to address hydrology and water quality. The Scott River TMDL Action Plan does not include such criteria, requirements, and prescriptions (such as Erosion Control Plan requirements, sediment waste discharge control requirements, and riparian vegetation retention requirements) for all timber harvest activities on non-federal lands in the Scott River watershed, except where such requirements may be specifically developed for an individual responsible party. It is important to note, however, that timber harvest projects in the Scott River watershed are still eligible for the Categorical Waiver under Waiver Categories A, B, D, E, and F, as appropriate. Timber harvest projects in the Scott River watershed are also eligible for individual waivers of WDRs, the general WDRs, individual WDRs, and ownership-wide WDRs as would be appropriate.

The General WDR provides an expedited program for the enrollment of the remainder of THPs in the region. Under the General WDR process, enrollment of THPs into the program is delegated to the Executive Officer so that each THP does not go through a new public notice process, Regional Water Board hearing, and Board vote on conformance with applicable requirements. Additionally, the General WDR requires that timber harvest operations be planned and designed to comply with water quality requirements through prevention and minimization techniques. The General WDR also requires the preparation of an erosion control plan, which includes an inventory of sediment discharge sources and a plan and schedule for the implementation of sediment discharge prevention and minimization measures.

The process of enrolling in either the Categorical Waiver or the General WDR is incorporated into the timber harvest project approval process. For those timber harvest activities not regulated by the Categorical Waiver or the General WDR, individual WDRs must be obtained.

Timber Harvest Activities on Federal Lands

In 2004, the Regional Water Board adopted the Categorical Waiver for Discharges Related to Timber Activities on Federal Lands Managed by the United States Department of Agriculture (Order R1-2004-0015). Timber Activities on federal lands must meet several conditions to qualify for the Categorical Waiver. These conditions include, among other provisions, conducting an environmental review of the project pursuant to the National Environmental Protection Act (NEPA), the maintenance of a water quality program consistent with the Basin Plan, and a verification system acceptable to the Regional Water Board, including, but not limited to, inspection, surveillance, enforcement, and monitoring of management practices.

5.1.10.3 Habitat Conservation Plans

A habitat conservation plan (HCP) is a document that must accompany an application for an incidental take permit. An incidental take permit is required when non-federal activities will result in the take[5] of a threatened or endangered species, in accordance with Section 10 of the federal Endangered Species Act. An HCP describes how activities will be conducted so that effects on the species are adequately minimized and mitigated. Aquatic HCPs that focus on endangered or threatened anadromous salmonids are likely to include management practices and control measures that affect water quality, including sediment waste discharges and elevated water temperatures.

The Regional Water Board recognizes that HCPs may be effective and appropriate mechanisms to prevent, minimize, and control sediment waste discharges and elevated water temperatures in the Scott River watershed. Therefore, where a HCP is developed, Regional Water Board staff shall work with the HCP holder to develop, for Board consideration, ownership-wide waste discharge requirements (WDRs) for activities covered by the HCP, with any additional restrictions necessary to protect water quality and beneficial uses. If appropriate, ownership-wide WDRs may be specific to the entire Scott River Hydrologic Area, or to individual hydrologic sub-areas, super planning watersheds, or planning watersheds. In the absence of ownership-wide WDRs, timber harvest activities shall continue to adhere to the timber harvest project review process and the General WDRs or Categorical Waiver, as appropriate.
Within the Scott River watershed, Fruit Grower's Supply Company, LLC (FGS) is currently developing a HCP that will address management activities for their timber harvest operations, roads, hillslope practices, and riparian management practices. FGS is the second largest timberland owner in the Scott River watershed, after the USFS. Regional Water Board staff are now working with, and shall continue to work with, FGS to incorporate necessary anthropogenic sediment waste discharge control measures, riparian protection measures, other water temperature related measures, monitoring, and adaptive management into the HCP.

5.1.11 Implementation Actions for the United States Forest Service

The U.S. Forest Service (USFS) controls approximately forty one percent (213,000 acres) of land in the Scott River watershed. Timber harvest activities and roads on USFS land are sources of both sediment waste discharges and elevated water temperatures. This section discusses USFS efforts to address sediment waste discharges from roads and other sources, elevated water temperatures caused by timber harvest activities, and both sediment and temperature issues related to grazing of livestock. The section concludes with a discussion of implementation actions to address sediment waste discharges and elevated water temperatures.

5.1.11.1 Sediment-Related Efforts

The USFS conducted an inventory of sediment waste discharge sources, including roads, as part of the Lower Scott and Callahan Ecosystem Analyses (USFS, 2000b; USFS, 1997). Through this process, the USFS has inventoried at least twenty percent of their roads. The inventories

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[5] Per the federal Endangered Species Act, take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect any threatened or endangered species. Harm may include significant habitat modification where it actually kills or injures an listed species through impairment of essential behavior, such as reproduction (USFWS 2004).

identified roads, stream crossings, and unstable areas that require sediment reduction, temperature moderations, and/or restoration. The inventory methodology is described in the *Field Guide. Explanations & Instructions for Klamath National Forest Road Sediment Source Field Inventory Form* (USFS, 2000a). Inventoried roads types include roads used for general public access, roads used for timber harvest activities, and cooperative roads that are the shared responsibility of the USFS and another responsible party. The USFS has also prioritized each site into high, medium, and low categories based on the assessed risk to the most sensitive resource possibly impacted if no restoration or remediation is implemented. The Ecosystem Analyses, however, do not describe how and when sediment waste discharge sites are to be repaired and managed.

5.1.11.2 Temperature-Related Efforts

The USFS administers the Klamath National Forest Land & Resource Management Plan (KLRMP). The KLRMP provides the overall management direction for lands within the Klamath National Forest (KNF), which includes the Scott River watershed. The President's Forest Plan for the Pacific Northwest, which includes an Aquatic Conservation Strategy, is applicable to the KNF. The Aquatic Conservation Strategy elucidates the *Standards and Guidelines for Riparian Reserves* that, for the most part, provide no-harvest and reduced-harvest buffers around fish bearing streams, other wildlife sensitive streams, unstable slopes, and other sensitive features.
In simplest terms, the USFS defines Riparian Reserves as forest land allocations intended to protect riparian areas. Riparian Reserves are also defined as lands along streams, unstable areas, and potentially unstable areas where special standards and guidelines direct land use (USDA-USDI BLM 1994, USDA 2004). Each USFS management district can tailor the riparian reserve buffers of the President’s Aquatic Conservation Strategy to conform to local conditions. The Riparian Reserve buffer widths proposed by the USFS for the Lower Scott River and Callahan management areas, specific to reserve types, are included in Table 5.3 and Table 5.4.

Within the Riparian Reserve buffers, timber harvest is prohibited unless consistent with attaining Aquatic Conservation Strategy objectives, and there are restrictions and management practices pertaining to road use and construction, livestock grazing, mineral extraction, and recreation. Additionally, prohibitions for fuel wood cutting apply, with a few exceptions. The USFS must retain a Riparian Reverse that is sufficient to assure protection of aquatic and riparian function, as well as consider the benefits to riparian dependent and associated species.

Regional Water Board staff has determined that the Interim Riparian Reserves in the Scott River Ranger Districts (Tables 5.3 and 5.4) appear to adequately protect the beneficial uses of water from temperature related effects of timber harvest operations. The Riparian Reserve buffers

Table 5.3
Recommended Interim Riparian Reserve Buffer Widths
for the Lower Scott River Management Area[1]

Riparian Reserve Type	Interim Buffer Widths
Fish-bearing streams.	340 feet or two site potential trees. [2]

Permanent, flowing, non-fish bearing streams; wetlands >1-acre; intermittent streams; marshes and springs.	170 feet or one site potential tree.
Unstable or potentially unstable lands, including dormant landslide toe zones.	340 feet or two site potential trees.

[1] Lower Scott Ecosystem Analysis, June 2000, p.3-8; 5-11.
[2] One site potential tree is 170 feet.

Table 5.4
Recommended Interim Riparian Reserve Buffer Widths for the Callahan Management Area[1]

Riparian Reserve Type	**Interim Buffer Widths**
Fish-bearing streams, lakes and natural ponds.	300 feet or two site potential trees. [2]
Permanent, flowing, non-fish bearing streams; wetlands >1-acre; intermittent streams; marshes and springs; constructed ponds and reservoirs.	150 feet or one site potential tree.
Wetlands <1-acre.	One-half tree height beyond riparian vegetation.
Unstable or potentially unstable lands, including dormant landslide toe zones.	Included in Riparian Reserve, subject to local interpretation.

[1] Callahan Ecosystem Analysis, March 1997, p. X-13.
[2] One site potential tree determined for the Callahan Management Area is 150 feet.

should, over time, result in increases in the riparian canopy, which will decrease high water temperatures. The buffers will also encourage the unfettered growth of riparian vegetation toward a late-seral community. The buffers will also be beneficial in controlling sediment waste discharges as riparian vegetation provides a filter to slow down and trap sediment before it is discharged to a water body.

5.1.11.3 Grazing-Related Efforts

Nearly all of the grazing of range cattle in the Scott River watershed involves driving and dispersing livestock to advantageous forage areas: from private ranches to forested lands managed by the USFS during late spring, summer, and early fall, and then back to private ranches, mostly on the valley floor, for the intervening time periods (USFS, 1997; USFS, 2000b). Past free range livestock grazing, mostly from the mid-1800s up to the mid-1900s, by cattle, sheep, horse and mule resulted in damage to aquatic resources in the Scott River watershed. This damage is most notably reflected in increased erosion, siltation, and habitat declines in riparian areas and associated watercourses (USFS, 2000b).

To manage the amount of cattle grazing on public land, the USFS has contracts for six allotments with cattle ranchers to allow grazing on 29,885 acres. Four of these allotments are entirely within the Scott River watershed, while two allotments span the watershed boundary. The number of cattle allowed for all six allotments is approximately 350 head of cattle, compared to an estimated 2,000 animals of all types prior to 1905, the date when the national forest and the concept of forest reserves were established (USFS, 2000b).

The USFS implements best management grazing strategies designed to lessen impacts to water quality that are detailed in a joint management agency document titled: *Riparian Area Management 1997* (USDA/USDI, 1997). In general, although livestock grazing is much reduced compared to historic conditions, the USFS is concerned that in some grazing allotments riparian shrub habitat may continue to be impacted by cattle where shrub utilization is high. In response to these concerns, the USFS monitors riparian areas in allotments in cooperation with allotment lessees. Some of the implemented mitigations in riparian corridors include deferred and rotational livestock grazing and riparian exclusionary fencing (USFS, 2000b).

5.1.11.4 Implementation Actions

In order to prevent, minimize, and control sediment waste discharges and elevated water temperatures on federal land in the Scott River watershed, the Regional Water Board shall work with the USFS to draft and finalize a Memorandum of Understanding (MOU). The MOU shall be drafted and ready for consideration by the appropriate decision-making body(ies) of the USFS within two years of the date the TMDL Action Plan takes effect. The MOU shall address the following contents:

Contents Related to Sediment Waste Discharges:

1. A date for the completion of an inventory of all sediment waste discharge sites and all roads on USFS land within the Scott River watershed.
2. A date for the completion of a priority list of sediment waste discharge sites. Prioritization criteria may be based off the threat to water quality from each individual sediment waste discharge site or the benefit to beneficial uses and water quality from focusing control activities within a planning watershed or along a stream reach.
3. A date for the completion of a schedule for the repair and control of sediment waste discharge sites.
4. A date for the completion of a document describing the sediment control practices to be implemented by the USFS to repair and control sediment waste discharge sites.
5. A description of sediment control practices, road maintenance practices, and other management measures to be implemented by the USFS to prevent future sediment waste discharges.
6. A monitoring plan to ensure that sediment control practices are implemented as proposed and effective at controlling discharges of sediment waste.
7. A commitment by the USFS to complete the inventory, develop the priority list, develop and implement the schedule, develop and implement sediment control practices, implement the monitoring plan, and conduct adaptive management.

Contents Related to Elevated Water Temperatures:

1. A commitment by the USFS to make permanent and implement the Riparian Reserve buffers width requirements.
2. A monitoring plan to ensure that the Riparian Reserve buffer widths are effective at preventing or minimizing effects on natural shade.
3. A commitment by the USFS to implement the monitoring plan and conduct adaptive management.

Contents Related to Grazing Activities:

1. A date for the completion of a description of existing grazing management practices and riparian monitoring activities implemented in grazing allotments.
2. A commitment by the USFS and the Regional Water Board to determine if existing management practices and monitoring activities are adequate and effective at preventing, reducing, and controlling sediment waste discharges and elevated water temperatures.
3. A commitment by the USFS to develop revised management practices and monitoring activities should existing measures be inadequate or ineffective, subject to the approval of the Regional Water Board's Executive Officer.
4. A commitment by the USFS/BLM to implement adequate and effective grazing management practices and monitoring activities and to conduct adaptive management.

In developing the MOU, the Regional Water Board shall work with the USFS to develop time lines that take into consideration USFS resources.

Through the development, review, and implementation of the MOU, Regional Water Board staff shall determine the appropriate permitting or enforcement actions necessary to prevent, minimize, and control sediment waste discharges and elevated water temperatures from USFS lands in the Scott River watershed. Such actions include, but are not limited to, WDRs, waivers of WDRs, cleanup and abatement orders, or other appropriate permitting or enforcement action(s).
Additionally, the Regional Water Board shall continue to implement *Order No. R1-2004-015, Categorical Waiver for Discharges Related to Timber Activities on Federal Lands Managed by the United States Department of Agriculture*. When the waiver expires on March 24, 2009, the Regional Water Board maintains the option of renewing the order. If it is determined that the prescriptions of the MOU are implemented and effective at controlling sediment waste discharges and elevated water temperatures, Regional Water Board staff may recommend that an ownership-wide (in lieu of project-specific) waiver of WDRs be considered as part of an adaptive management approach to TMDL implementation.

Should the USFS choose not to participate in the development, finalization, and implementation of a MOU, Regional Water Board staff shall initiate appropriate permitting or enforcement actions on timber harvest activities on USFS land within the Scott River watershed, for consideration by the Board, without waiting for cooperative efforts from the USFS. Again, such actions include, but are not limited to, the development of WDRs for Board consideration.

5.1.12 Implementation Actions for the United States Bureau of Land Management

The United States Bureau of Land Management's (BLM) manages approximately 200 acres of land (< 1%) in the Scott River watershed, which consists mostly of dry foothills with ephemeral streams in the east-side portions of the watershed. The primary land use on BLM lands in the Scott River watershed is cattle grazing, although timber harvest, road use, and other activities are present or may occur in the future. Grazing activities include grazing allotments. Given the ecological characteristics and the dispersed nature of BLM land in the east side of the watershed, cattle grazing is expected to have a smaller impact to water quality on BLM lands than in the more temperate south and west areas of the watershed managed by the USFS. In order to lessen impacts to water quality from grazing activities, BLM implements best management grazing strategies that are detailed in a joint management agency document titled: *Riparian Area Management 1997* (USDA/USDI, 1997).

In order to prevent, minimize, and control sediment waste discharges and elevated water temperatures from BLM lands in the Scott River watershed, the Regional Water Board shall work with the BLM to draft and finalize a Memorandum of Understanding (MOU). The MOU shall be drafted and ready for consideration by the appropriate decision-making body(ies) of the BLM within two years of the date the Scott River TMDL Action Plan takes effect. The MOU shall address the following contents:

Contents Related to Sediment Waste Discharges:

1. A date for the completion of an inventory of all sediment waste discharge sites and all roads on BLM land within the Scott River watershed.
2. A date for the completion of a priority list of sediment waste discharge sites.
3. A date for the completion of a schedule for the repair and control of sediment waste discharge sites.
4. A date for the completion of a document describing the sediment control practices to be implemented by the BLM to repair and control sediment waste discharge sites.
5. A description of sediment control practices, road maintenance practices, and other management measures to be implemented by the BLM to prevent future sediment waste discharges.
6. A monitoring plan to ensure that sediment control practices are implemented as proposed and effective at controlling discharges of sediment waste.
7. A commitment by the BLM to complete the inventory, develop the priority list, develop and implement the schedule, develop and implement sediment control practices, implement the monitoring plan, and conduct adaptive management.

Contents Related to Elevated Water Temperatures

1. A commitment by the BLM to make permanent and implement the Riparian Reserve buffers width requirements.
2. A monitoring plan to ensure that the Riparian Reserve buffer widths are effective at preventing or minimizing effects on natural shade.
3. A commitment by the BLM to implement the monitoring plan and conduct adaptive management.

Contents Related to Grazing Activities

1. A date for the completion of a description of existing grazing management practices and riparian monitoring activities implemented in grazing allotments.
2. A commitment by the BLM and the Regional Water Board to determine if existing management practices and monitoring activities are adequate and effective at preventing, reducing, and controlling sediment waste discharges and elevated water temperatures.
3. A commitment by the BLM to develop revised management practices and monitoring activities should such measures be inadequate or ineffective, subject to the approval of the Regional Water Board’s Executive Officer.

4. A commitment by the BLM/BLM to implement adequate and effective grazing management practices and monitoring activities and to conduct adaptive management.

In developing the MOU, the Regional Water Board shall work with the BLM to develop time lines that take into consideration BLM resources.

Through the development, review, and implementation of the MOU, Regional Water Board staff shall determine the appropriate permitting or enforcement actions necessary to prevent, minimize, and control sediment waste discharges and elevated water temperatures from BLM lands in the Scott River watershed. Such actions include, but are not limited to, WDRs, waivers of WDRs, cleanup and abatement orders, or other appropriate permitting or enforcement action(s).

Should the BLM choose not to participate in the development, finalization, and implementation of a MOU, Regional Water Board staff shall initiate appropriate permitting or enforcement actions on timber harvest activities on BLM land within the Scott River watershed for consideration by the Board without waiting for cooperative efforts from the BLM.

5.1.13 Grazing Implementation Actions

In general, the U.S. EPA lists agriculture, particularly livestock management, as having greater impacts on river contamination than any other non-point pollution source (USEPA, 2005). In the Scott River watershed, grazing and related activities discharge sediment waste and cause elevated water temperatures, especially in locations where grazing animals have direct access to a water body. Although not quantified in the Sediment Source Analysis, grazing animals discharge sediment waste through direct soil disturbance. Additionally, when grazing animals trample, eat, and suppress vegetation, soil stability is reduced. Water temperature is affected when grazing animals trample, eat, and suppress vegetation that would otherwise provide shade to a water body, thereby causing an increase in water temperatures.

5.1.13.1 Encouragement of Grazing-Related Sediment and Temperature Control Actions

The Regional Water Board encourages the parties responsible for grazing activities to take the necessary actions to prevent, minimize, and control sediment waste discharges and elevated water temperatures. Examples of recommended grazing management practices are listed in Table 5.5.

5.1.13.2 Grazing and Riparian Management Plans

In order to further prevent, minimize, and control sediment waste discharges and elevated water temperatures from grazing activities on private lands in the Scott River watershed, the Regional Water Board's Executive Officer shall require responsible parties, on an as-needed, site-specific basis, to develop and submit a Grazing and Riparian Management Plan and a Monitoring Plan. Should human activities that will likely result in sediment waste discharges and/or elevated water temperatures be proposed or identified, through a Grazing and Riparian Management Plan or by other means, the responsible party(ies) shall be required to implement their Grazing and Riparian Management Plans through appropriate permitting or enforcement actions. Such requirements shall be specified in waste discharge requirements (WDRs), waivers of WDRs, cleanup and abatement orders, or other appropriate permitting or enforcement action(s). Responsible parties are subject to such requirements if livestock grazing activities on their property(ies) are discharging or threatening to discharge sediment waste and/or causing or threatening to cause elevated water temperatures to water bodies in the Scott River watershed.

A Grazing and Riparian Management Plan shall describe, in detail, (1) sediment waste discharges and sources of elevated water temperatures caused by livestock grazing, (2) how and when such discharges are to be controlled and monitored, and (3) management practices that will prevent and reduce future discharges.

The Porter-Cologne Water Quality Control Act (California Water Code, Division 7) provides the Regional Water Board with the primary authority for requiring Grazing and Riparian Management Plans and monitoring. The authority to require dischargers to identify, assess, and monitor sediment waste and/or elevated water temperatures is found in California Water Code

Table 5.5
Recommended Grazing Management Practices

Timing & Location Practices	Defer grazing. Postpone grazing or rest grazing land for a prescribed period of time.
	Planned grazing systems. Use two or more grazing units and alternatively rest a unit in sequence for a period of time, generally years, with shorter rest periods throughout the year or growing season.
	Use improved upland forage if available. This practice can lure cows away from the riparian corridor (Ehrhart & Hansen, 1998, as cited by Oregon State, 2005).
	Proper grazing use. Select an intensity of grazing that maintains sufficient pasture and field cover crops to protect the soil and nearby sensitive areas, such as riparian corridors and instream habitat.
	Proper woodland grazing. Select an intensity of grazing in wooded-forested areas that maintains adequate cover to protect the soil and nearby sensitive areas, such as riparian corridors and instream habitat.
Water Supply/Use Practices	Water troughs. Install water troughs or tanks for stock watering outside of riparian areas, where possible.
	Stock Water Conveyances. To minimize water losses from evaporation to the atmosphere and subsurface infiltration via porous or fractured diversion ditches and canals, replace earthen and open ditch stock watering conveyance systems with enclosed pipe.
	Wells. Construct new wells or make improvements to existing wells to keep livestock away from sensitive areas.

	Springs. Develop existing springs located outside of sensitive areas. Care should be taken so that spring development does not impact existing beneficial uses.
	Water Use. To accurately gage water rights allotments of water users, install flow meters or other proven and reasonably economical flow measurement technology to surface and groundwater diversions at the point of diversion from the parent watercourse and/or the wellhead.
Livestock Access Limitation Practices	Manage stock watering and livestock movement so that incursions into riparian areas and stream channels are minimized.
	Fencing. When other management practices fail to reduce livestock from riparian areas and watercourses, fencing and/or other permanent structures should be constructed as a barrier to control livestock access to such areas.
	Salt Licks. Locate salt licks away from riparian areas and water bodies. A distance of 1/3 mile is ideal (Ehrhart & Hansen, 1998).
	Stream Crossings. Provide a stabilized area to control access, for both livestock and machinery, and reduce erosion.
	Herding and riding of livestock. If passive grazing strategies fail to keep livestock out of sensitive areas, forcibly herd livestock from such areas.
General Practices	Develop a Ranch Water Quantity-Quality Conservation Plan.

(CWC) Section 13267. The authority to require dischargers to control such discharges is found in CWC Section 13304 (pertaining to cleanup and abatement activities) and Section 13260 (pertaining to WDRs). Additionally, the requirements to implement a Grazing and Riparian Management Plan through WDRs, waivers of WDRs, cleanup and abatement orders, or other appropriate permitting or enforcement action satisfies the requirements of the State *Policy for the Implementation and Enforcement of the Nonpoint Source Pollution Control Program*.
As stated above, any responsible party is potentially subject to the requirement to develop, submit, and implement a Grazing and Riparian Management Plan if livestock grazing activities on their property(ies) are discharging or threatening to discharge sediment waste and/or causing or threatening to cause elevated water temperatures to a water body in the Scott River watershed. However, the Regional Water Board's Executive Officer shall require a Grazing and Riparian Management Plan and monitoring on an as-needed, site-specific basis.

Within two years of the date that the TMDL Action Plan takes effect, specific criteria shall be developed for determining when a Grazing and Riparian Management Plan shall be required. However, nothing precludes the Executive Officer from requiring Grazing and Riparian Management Plan prior to the establishment of the criteria. Until specific criteria are developed, grazing and riparian management plan requirements shall be focused on grazing activities that are the greatest threat to water quality. The threat to water quality shall be determined by the impacts of the discharge or threatened discharge on the beneficial uses of the Scott River and its tributaries, and the significance of the discharge, including such factors as volume, percent delivery, and the feasibility and reasonability of control.

It is important to note that Grazing and Riparian Management Plans are not likely to be required in large numbers until after encouragement efforts have the opportunity to prevent, minimize, and control discharges. These efforts include encouraging the Siskiyou Resource Conservation District and the Scott River Watershed Council to implement the grazing management practices listed in Table 5.5. Should encouragement efforts fail to be adequate and effective at preventing, minimizing, and controlling discharges, the Regional Water Board shall increase the use of existing authorities and regulatory tools, including increasing the number of Grazing and Riparian Management Plans required of individual responsible parties/dischargers.

Should a responsible party/discharger be required to develop, submit, and implement a Grazing and Riparian Management Plan and conduct monitoring, the responsible party/discharger will be notified in writing of the requirements. It is likely that, under the authority of CWC 13267, the responsible party/discharger will first be asked to submit any pertinent information on grazing-caused discharges and management practices that has already been collected by the responsible party/discharger. Following analysis of this information, the Executive Officer shall determine if further information, in the form of a Grazing and Riparian Management Plan for example, is required. A Grazing and Riparian Management Plan will likely not be required if the responsible party/discharger has already developed and is implementing grazing practices that are adequate and effective at preventing, minimizing, and controlling sediment waste discharges and elevated water temperatures. Additionally, the Executive Officer shall specify in writing the required contents of a Grazing and Riparian Management Plan.

5.1.14 Implementation Actions for the Scott River Watershed Council and the Siskiyou Resource Conservation District

The Siskiyou Resources Conservation District (SRCD), like other resource conservation districts, is a local unit of government established under state law to carry out natural resource management programs at the local level. Resource conservation districts help landowners manage and protect land and water resources on nearly ninety-eight percent of the private lands in the United States (National Association of Resource Conservation Districts 2005). The SRCD seeks funding and provides technical assistance for landowners throughout the Scott River watershed. Past efforts include stream restoration projects, irrigation water application and water diversion management, low-flow management studies, stock water conservation management practices, and other programs. The SRCD cannot regulate responsible parties and other stakeholders in land use practices that may be related to TMDLs or other local, state, or federal regulatory mandates. However, the continued participation by the SRCD in the Scott River watershed is valuable for water quality and TMDL-related efforts. The experience of the SRCD with outreach and education to landowners is particularly valuable.

The Scott River Watershed Council (SRWC) is sponsored by the SRCD and provides a multi-interest effort to cooperatively seek solutions, to help manage local resources, and to solve related problems. The SRWC is composed of a diverse group of community members. State and local agency representatives act in an advisory capacity. The SRWC's primary role is to inform the community on resource issues, to aid in resource management, and to recommend prioritized project opportunities in the Scott River watershed to the SRCD for funding and implementation. Together, the SRCD and the SRWC work cooperatively to monitor the effectiveness of implemented programs, plans, and projects.

This section discusses one of the SRWC's primary efforts, the Strategic Action Plan, which addresses multiple sources of sediment waste discharges and elevated water temperatures. Additionally, grazing and historic mining activities are discussed. This section concludes with implementation actions to address discharge sources through the SRCD and the SRWC.

The SRCD is also working with the California Department of Fish and Game to develop a watershed-wide Incidental Take Permit to address the listing of coho salmon as a threatened species under the state Endangered Species Act. See Section 5.1.16.4 for more information.

5.1.14.1 Strategic Action Plan

The SRWC completed the Scott River Watershed Council Strategic Action Plan in 2004. The Strategic Action Plan forms the basis for setting priorities for future projects and management practices to be supported by the SRWC, the communities within the watershed, and the available funding sources. Included in the Strategic Action Plan are identified goals, priorities, and strategic actions that apply to fisheries, vegetation and habitat restoration, geology and soils, hydrology and water supply, water quality, land use, fire, community resources and socio-economics, community relations and education, and monitoring. Table 5.6 includes just several examples of the ninety-three strategic actions listed in the Strategic Action Plan. Table 5.10, located towards the end of this Staff Report, compares the actions of the Strategic Action Plan,

Table 5.6 Strategic Actions from the Strategic Action Plan (SRWC 2004)
Identify, prioritize and seek funding for fish habitat riparian restoration opportunities (F-1-B.b).
Evaluate locations where historic side channels/braids/wetlands can be connected to the floodplain without negatively impacting existing land uses, and work to implement feasible projects (F-2-C.a).
Establish artificial beaver dams where appropriate (F-2-C.b).
Evaluate riparian planting projects and make recommendations to improve planting programs. Include in the evaluations an assessment of why projects failed and modify accordingly (F-2-E.a).
Evaluate the geomorphology of the mainstem Scott River channel to identify potential demonstration projects (F-2-F.a).
Identify locations of thermal refugia (F-2-G.a).
Evaluate and recommend enhancements to expand thermal refugia (F-2-G.b).
Evaluate the ground and surface water recharge effects of irrigation ditches (W-1-A.a).
Working on the development of a groundwater study.
Where feasible, construct water storage on- and off-channel (W-1-B.a).
Investigate the feasibility and potential level of cooperation to temporarily dedicate water for instream flows during emergency situations. If feasible and acceptable, implement ongoing program (W-1-B.f).
Develop a manual to educate users about potential water conservation practices and why they are needed during low flow years (W-1-C.a).
Facilitate compliance with water rights as contained in the three adjudications in Scott Valley (W-1-C.b).
Where feasible, install systems that reuse tail or end water or percolate it through the ground to cool it (W-2-A.d).

Educate road users about road-related erosion problems and remedies (W-2-B.b).
Identify and correct existing drainage and erosion problems within the road prism, attempting to mitigate those sites with the greatest potential for impacting the stream system (W-2-B.c).
Develop an information handbook and work with livestock owners and land managers on timing and movement of grazers to minimize stream impacts (L-2-B.a).
Develop a standardized monitoring protocol for pre- and post-project monitoring that can be used by any party (M-1-D.a).
Offer photo monitoring seminars (M-2-C.a).
Develop a MOU with landowners and agencies on data sharing (M-2-E.a).

the Coho Recovery Strategy, the Incidental Take Permit, and the TMDL Action Plan. The strategic actions listed in both of these tables are those actions that most directly apply to sediment and temperature issues.

Many of the strategic actions will be of direct benefit to water quality in the Scott River watershed and will address sediment waste discharges and elevated water temperatures. Additionally, the community-based nature of the SRWC, their accomplishments to date, their history in the watershed, and the trust they have established with a diverse group of interested individuals and community members make the SRWC highly suited to implement sediment and temperature control practices. Because of their unique standing in the watershed, the SRWC is also in the valuable position of being able to effectively encourage and assist individuals in developing and implementing management practices that prevent, minimize, and control discharges.

5.1.14.2 Grazing Management Practices

In regards to grazing activities, many management practices have already been developed by the Farm Bureau, the University of California Cooperative Extension, the SRCD, and the NRCS, among others. Several of these management practices are listed in Table 5.5 as recommended actions for those that oversee and manage grazing activities in the Scott River watershed.

5.1.14.3 Historic Mining Issues

Within the Scott River watershed, historic gold mining activities primarily consisted of large scale dredging, hydraulic, and sluice mining activities. Such activities largely occurred along the mainstem Scott River downstream of Callahan, in Quartz Valley, in Oro Fino Creek, Shackleford Creek, and Mill Creek watersheds, with lesser activity in French Creek and the East Fork Scott River (USFS, 2000). The effects of these historic mining activities are still evident to this day.

The most persistent legacy effects are those of a large “Yuba Dredge” that dredged river and valley floor alluvium to bedrock and then deposited extensive tailing (spoils) piles behind the dredge as it moved forward searching for gold. This environmentally destructive method of mining left a five to six mile long reach of gravel-cobble sized tailing piles in the upper mainstem Scott River and its floodplain from Callahan to just above Fay Lane, and also in portions of McAdams and Wildcat Creeks (SRWC, 2004; Quigley et al., 2001).

Historic tailing piles in the Scott River watershed, and especially the tailing piles around Callahan, have caused and/or are causing elevated sediment loads and water temperatures in the Scott River and its tributaries. First, the historic mining left sediment deposits that remain in the system today, cutting off tributary streams from the mainstem Scott River. This results in tributary reaches that dewater and prevent salmonid passage. Second, the tailing piles have confined and constricted the Scott River, which encourages high energy, flushing storm water events to pass quickly downstream. As a consequence, during storm events, the rapidly moving flows uproot and carry shade producing riparian vegetation that may have been established during low flow conditions, either naturally or through restoration projects (SRWC, 2004). Additionally, the rapidly moving flows prevent the anchoring of large wood and other channel modifying structures that could provide necessary instream salmonid habitat (Quigley, 2003). Finally, historic mining activities included the building of unscreened diversion channels, dams often used to store water for diversions, and inadequate road-stream crossings. Fortunately, these problems have largely been eliminated through efforts of the CDFG, the USFS, and local watershed groups such as the SRWC (SRWC, 2004; USFS, 2000).

The Strategic Action Plan (2004) includes a discussion on vegetation and habitat restoration that incorporates recommended strategic actions pertinent to the dredge tailings. Several of these strategic actions are listed in Table 5.6.

5.1.14.4 Implementation Actions

In order to prevent, minimize, and control sediment waste discharges and elevated water temperatures from a variety of sources in the Scott River watershed, the Regional Water Board shall take the following two actions.

First, the Regional Water Board and staff shall increase efforts to work cooperatively with the SRCD to provide technical support and information to willing individuals, landowners, and community members in the Scott River watershed and to coordinate educational and outreach efforts.

Second, the Regional Water Board shall encourage the SRWC to (1) implement the strategic actions specified in the Strategic Action Plan and (2) assist landowners in developing and implementing management practices that are adequate and effective at preventing, minimizing, and controlling sediment waste discharges and elevated water temperatures. Such actions should address almost all sources of sediment waste and elevated water temperatures in the watershed, including grazing management activities and dredge tailing restoration specifically mentioned above. By implementing the strategic actions, the SRWC will greatly aid in the attainment of sediment and temperature water quality standards in the Scott River watershed. Additionally, implementing the strategic actions will likely result in a higher priority ranking for the SRWC when applying for grant funding from the Regional and State Water Boards.

5.1.15 Implementation Actions for the Natural Resources Conservation Service and University of California Cooperative Extension

The Natural Resources Conservation Service (NRCS) provides aid in securing financial assistance and provides technical support for the implementation of beneficial management practices throughout the United States. Several programs may be available to agricultural interests in the Scott River watershed, including an Irrigation and Water Management Program under the umbrella of the NRCS Conservation Planning Program.

The NRCS does not get involved in a regulatory capacity directing responsible parties and other stakeholders in administering recommendations for land use practices that may be related to TMDLs or other local, state, or federal regulatory mandates. However, the continued participation by the NRCS in the Scott River watershed is valuable for water quality and TMDL-related efforts. The technical resources available to responsible parties and stakeholders through the NRCS is particularly useful for preventing, minimizing, and controlling sediment waste discharges and high water temperatures. Therefore, the Regional Water Board shall increase efforts to work cooperatively with the NRCS to provide technical support and information to willing responsible parties and stakeholders in the Scott River watershed and to coordinate educational and outreach efforts. The Regional Water Board encourages the NRCS to consult with other agencies, including the Regional Water Board, on activities that may affect water quality and compliance with water quality objectives.

University of California Cooperative Extension also provides advice and support to the agricultural community, including on issues related to compliance with water quality regulation and regulatory programs. The Rangeland Water Quality Management planning process is an example of such advice and support. The Regional Water Board will continue to work cooperatively with UCCE to provide technical support and information to willing responsible parties and stakeholders in the Scott River watershed and to coordinate educational and outreach efforts.

5.1.16 Implementation Actions for the California Department of Fish and Game

The California Department of Fish and Game (CDFG) is involved in water quality issues in the Scott River watershed through several programs, including 1600 permits, outreach efforts, and the Coho Recovery Strategy. These programs are discussed below.

5.1.16.1   1600 Permits

The CDFG reviews and inspects activities on private land for compliance with California Fish and Game Code Sections 1600-1616. These sections apply to all land management activities that may or will result in alterations to watercourses. Section 1602 states paraphrastically that an entity may not substantially divert or obstruct the natural flow of, or substantially change or use any material from the bed, channel, or bank of, any river, stream, or lake, or deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it may pass into any river, stream, or lake, unless the permit applicant has prescribed measures that either avoid, and/or mitigate altering or damaging the bed, channel, or bank of watercourses so as not to harm the beneficial uses of water. Section 161l is specific to timber harvest operations and to developing mitigations for stream crossings, culverts, bridges, etc., that are necessary for vehicular and other traffic. Additionally, Section 1611 requires that timber harvest plans detail what steps will be taken if water from a nearby watercourse is diverted or impounded for activities such as road watering for dust abatement and other uses associated with harvesting timber.

5.1.16.2 Outreach Efforts

The CDFG works in partnerships with the SRCD, private stakeholders, and other responsible parties. Their funding and cooperation with stakeholders has been instrumental in the implementation of stream restoration and enhancement projects in the Scott River watershed. In addition to providing funds and in-kind contributions, partners have been given support and funding by participating in SRWC planning and working committee meetings. Coordination of the SRWC is also supported through funding provided by the CDFG's California Coastal Salmon Recovery Program.

5.1.16.3 Coho Recovery Strategy

The CDFG has also developed a statewide *Recovery Strategy for California Coho Salmon* (Coho Recovery Strategy), which includes descriptions of the Scott River watershed and recommendations for the recovery of coho salmon that are specific to both the Scott River and Shasta River watersheds (CDFG, 2004). Implementation actions in the Coho Recovery Strategy are mostly of a general nature, but in many instances, address individual streams and reaches, and near-stream and upslope areas when deemed critical to the recovery of coho salmon habitat. Several actions from the Coho Recovery Strategy are paraphrased in Table 5.7.

Table 5.7
Tasks and Actions from the Coho Recovery Strategy (CDFG, 2004)

Topic/Source	**Action/Recommendation**	**Impairment(s)and/or Resource(s)** Primarily (X) and Secondarily (x)		
		Sediment	**Temperature**	**Habitat**
Riparian Vegetation	Encourage riparian restoration projects using locally native vegetation (HM-1-1c).	x	X	x
Riparian Vegetation	Continue riparian easement programs (HM-1-1d).	x	X	x
Riparian Vegetation	Educate non-agricultural landowners on the importance of not removing riparian vegetation (HM-4c).	x	X	x
Riparian Vegetation	Promote and encourage protection of riparian zones that are important for coho salmon through fencing or other measures (P-2).	x	X	x
Sediment	Improve spawning gravel quantity and quality. Develop a sediment budget. Design, secure funding, and implement projects (HM-4d).	X	x	x
Sediment	Identify, quantify, and remedy sources of fine sediment (HM-3d and HM-4c).	X	x	x
Roads	Where agricultural roads have a potential effect on coho salmon, conduct roads inventory and assessment. Implement remediation actions and monitor effectiveness (MA-1a).	X	x	X
Water Use	Determine unused diversion rights and approach those diverters about providing flows for instream use without impacting the water rights of others (WM-5b).	x	X	x
Water Use	Seek funding to conduct instream flow studies to determine flow-habitat relationships (WM-9).	x	X	X
Water Use	Provide a structured process for willing participants to donate, sell, or lease water or water rights to provide improved stream flow (WA-1).	x	X	X
Water Use	Acquire water rights that shall be dedicated to instream flow (WA-7).	x	X	X
Water Use	Initiate study on options for a tailings rehabilitation and water storage project (WA-5).	X	X	X
Groundwater	Prepare a comprehensive study to determine the current status of groundwater in the Scott Valley and its relationship to surface flows (WM-10b).	x	X	x
Dredge Tailings	Restore the Scott River flood plain in the Callahan Dredge Tailings reach (Scott HM-2c).	X	X	X

5.1.16.4 Incidental Take Permits

Section 1602 of the California Endangered Species Act prohibits the unauthorized take[6] of threatened species, including coho salmon. “The [CDFG] may authorize take of a listed species by issuing a permit, known as an ‘Incidental Take Permit,’ if the take is incidental to otherwise lawful activity, such as a permitted agricultural diversion, and any take is minimized and fully mitigated” (CDFG, 2005, p. 1). Parties whose activities may result in a take of coho can comply with Section 1602 by individually applying for an Incidental Take Permit.

Additionally, in order to ease possible burdens on landowners conducting certain activities in the Scott River watershed, the CDFG is currently working with the Siskiyou Resource Conservation District (SRCD) on a watershed-wide permitting approach. The activities covered by the Watershed-wide Incidental Take Permit include water diversion and irrigation activities, livestock management, fishery restoration projects, and vehicular use associated with the aforementioned activities.

Under the Watershed-wide Incidental Take Permit, the SRCD will be the permit holder allowing individual landowners to enroll in the program as sub-permittees. The sub-permittees will work directly with the SRCD, avoid a CDFG fee, and be protected from enforcement action under the Endangered Species Act.

In order to fully avoid, minimize, and mitigate for incidental take of coho salmon under the Watershed-wide Incidental Take Permit, the SRCD developed avoidance, minimization, and mitigation measures. The SRCD has also developed a plan to monitor effectiveness and compliance. The avoidance, minimization, and mitigation measures proposed by the SRCD as permit requirements are included in Table 5.8. For more information and details on these measures, please see the Incidental Take Permit application (SRCD, 2005c) available from the SRCD. Table 5.8 is a summary for information purposes only and is not intended to be a comprehensive or exhaustive list of all the measures included in the application.

As of the time of this writing, the SRCD has submitted their application to CDFG for their Watershed-wide Incidental Take Permit for Coho Salmon, and CDFG is reviewing the application. Changes to the scope of the permit and the avoidance, minimization, and mitigation measures may yet occur. The following information on the Watershed-wide Incidental Take Permit is based on the permit application (SRCD, 2005c).

A summary of the avoidance, minimization, and mitigation measures of the Watershed-wide Incidental Take Permit Application and the implementation actions of the Scott River TMDL Action Plan are listed in Table 5.9. A more extensive version of Table 5.9 can be found towards the back of this Staff Report in Table 5.10.

5.1.16.5 Implementation Actions

In order to prevent, minimize, and control sediment waste discharges and elevated water temperatures in the Scott River watershed, the Regional Water Board shall encourage the CDFG

[6] Take means to hunt, pursue, catch, capture, or kill, or attempt to hunt, purse, catch, capture, or kill.

and aid, where appropriate, in the implementation of necessary tasks, actions, and recovery recommendations as specified in the Coho Recovery Strategy. This process will likely involve the creation of an inter-agency working group. Such a working group would likely include representatives from other agencies as well. Regional Water Board staff also intend to work with CDFG staff in the development of the Watershed-wide Incidental Take Permit, especially in relation to criteria for watercourse crossings and the requirements for the grazing management plan.

Table 5.8
Incidental Take Permit Application's
Avoidance, Minimization, and Mitigation Measures

Topic	Measures
In-stream Habitat Improvement	• The SRCD shall identify, design, and install spawning area enhancement structures in areas where spawning gravels are not plentiful. • The SRCD shall install 20 in-stream structures, such as large woody debris and boulder structures to improve pools and cover.
Fish Rescue	• The sub-permittee shall provide reasonable access to CDFG for fish rescue operations.
Fish Passage	• The sub-permittee shall modify or replace water diversion structures to allow for fish passage. • The SRCD shall modify or replace at least 5 diversion structures per year (35 – 40 existing structures currently impede fish passage). • The SRCD shall install a fish ladder at the Scott Valley Irrigation District diversion head to provide for juvenile coho passage. • The SRCD shall install a boulder weir and improved head works at Farmers Ditch. • The SRCD shall develop a project to provide fish passage over an existing pond on Rail Creek.
Fish Screens	• The sub-permittee shall fit each water diversion structure with an appropriate fish screen. • The sub-permittee shall use and maintain fish screens.
Water Use	• The sub-permittee shall install head gates and/or devices to measure/control diverted water. • The SRCD shall install at least 5 head gates and/or devices to measure/control diverted water per year (40 active diversions are currently in need of such structures). • The sub-permittee shall adhere to water rights. • The SRCD shall develop a water diversion verification method (e.g., watermaster service). • The SRCD has requested the permit include a condition that any measure specified in the permit be modified so as to eliminate any significant risk of a sub-permittee losing a portion or all of their water right if such a risk should exist.

Table 5.8
Incidental Take Permit Application's
Avoidance, Minimization, and Mitigation Measures

Topic	Measures
In-stream Flow	• In French and lower Shackleford creeks, the sub-permittee shall make diverted water usually used for agricultural purposes available for in-stream flow if connectivity with the Scott River is about to be broken prior to June 15. The SRCD shall pay the sub-permittee for the otherwise diverted water that is used for in-stream flow. • The SRCD shall develop the necessary legal steps and funding sources to allow for payments to sub-permittees for the otherwise diverted water that is used for in-stream flow. • The SRCD shall work with CDFG and water users to develop a water-saving solution to Fay Ditch, with saved water going to in-stream flow. • The SRCD shall develop and implement a contingency plan for dry and critically dry water years. The contingency plan will include measures to augment stream flow with groundwater, a plan to monitor irrigation starts and stops to minimize rapid reductions in stream flows, and a pilot program to evaluate the effectiveness of relocating rescued juvenile fish to upstream locations. • The SRCD shall work with sub-permittees diverting water for livestock to minimize the amount of water diverted. • The SRCD shall install an average of 3 livestock water systems per year that use groundwater instead of surface water, with saved water going to in-stream flow.
Riparian Fencing & Planting	• The sub-permittee shall install riparian fencing within a schedule specified by the SRCD. • The sub-permittee shall allow riparian fencing and planting to occur on their property. • The SRCD shall develop a riparian planting program. • The SRCD shall prioritize riparian fencing and planting activities.
Grazing Activities	• The sub-permittee shall ensure there is no intentional grazing of livestock within the bed, bank, or channel of the water bodies within the Scott River watershed without a grazing management plan approved and monitored by CDFG.
Roads	• From November 1 to April 15, the sub-permittee shall cross flowing streams only at prepared crossing sites with livestock and vehicles. These crossing shall meet specific criteria (see the permit application for details). • From November 1 to April 15, for the mainstem Scott River upstream of Young's Point Dam, including the East Fork Scott River, the sub-permittee shall cross flowing streams with livestock and vehicles only when redds are found to not be present.

Table 5.9
Summary Comparison of the Incidental Take Permit and the Scott River TMDL Action Plan

Topic	Incidental Take Permit Application	Scott River TMDL Action Plan
Primary Focus	Agricultural water use and livestock management.	All land uses in the watershed.
In-stream Habitat Improvement	Addresses through specific habitat improvement projects.	Does not address.
Fish Rescue	Addresses by allowing access to CDFG.	Does not address.
Fish Passage	Addresses through the modification / replacement of water diversion structures, fish screens, and specific fish passage projects.	Does not address.
Water Rights	Addresses through the use of water diversion measuring/control devices and adherence to water rights.	Addresses by requesting the County to study the groundwater and surface water issues.
In-Stream Flow	Addresses through water banking, planning for dry years, and specific water conservation projects.	Addresses by encouraging water conservation.
Riparian Fencing & Planting	Addresses through the use of riparian fencing and planting programs.	Addresses by encouraging the retention and restoration of vegetation and through the use of permitting and enforcement actions.
Grazing Activities	Addresses by ensuring no grazing in the bed, bank, or channel without a CDFG grazing management plan.	Addresses through the use of a Grazing and Riparian Management Plan, permitting and enforcement actions, and through MOUs with the USFS and BLM.
Roads	Addresses stream crossings.	Addresses all private roads in the watershed through the use of Erosion Control Plans and permitting and enforcement actions. Addresses County and State roads through MOUs.
Timber Activities	Does not address.	Addresses through the use of existing permitting programs and through MOUs with the USFS and BLM.
Flood Control & Bank Stabilization	Does not address.	Addresses by encouraging planting and stream bank restoration and through the use of existing permitting programs.
Dredge Mining	Does not address.	Addresses by investigating potential impacts.
Cooperative Efforts	Does not address.	Addresses through commitments to work cooperatively with SRCD, SRWC, NRCS, and CDFG.

5.2 PERMITTING AND ENFORCEMENT ACTIONS

Although the Regional Water Board prefers to pursue the implementation actions described in Section 5.1, the Regional Water Board shall take appropriate permitting and enforcement actions should any of the implementation actions described in Section 5.1 above fail to be implemented by the responsible party(ies) or should the implementation actions prove to be inadequate. The federal Clean Water Act and the California Water Code (CWC) authorize the Regional Water Board to use permitting and enforcement tools to control waste discharges and ensure attainment of water quality standards.

5.2.1 Permitting

Permitting tools that may be applicable include, but are not limited to:

1. The authority to require technical reports and reports on the conditions and operation of a facility, in accordance with CWC §13267.

2. The authority to require monitoring reports, in accordance with CWC §13267.

3. The authority to inspect a facility, in accordance with CWC §13267.

4. The permitting of the discharge of waste, or proposed discharge of waste, to waters of the state through Waste Discharge Requirements (WDRs), in accordance with Article 4 of the CWC. WDRs may take the form of individual or project-specific WDRs, watershed-specific WDRs, or general WDRs that are applicable to a specific activity.

5. The authority to waive the requirements for a WDR, in accordance with CWC §13269.

6. The permitting of a discharge of waste to waters of the United States through National Pollution Discharge Elimination System (NPDES) permits, in accordance with Section 402 of the Clean Water Act and CWC §13370.

7. The certification that a proposed activity which requires a federal permit or license complies with water quality standards, in accordance with Section 401 of the Clean Water Act.

5.2.2 Enforcement

Enforcement tools that may be applicable include, but are not limited to:

1. The authority to require a time schedule of specific actions to be taken, in accordance with CWC §13300.

2. The issuance of a cease and desist order, in accordance with CWC §13301.

3. The issuance of a cleanup and abatement order, in accordance with CWC §13304.

4. The authority to impose monetary liabilities or fines (administrative civil liabilities), in accordance with CWC §13268 and §13350.

Additionally, enforcement actions should be consistent with the State Water Board's *Water Quality Enforcement Policy*, adopted February 19, 2002, as SWRCB Res. No. 2002-0040, and as subsequently amended. The Enforcement Policy has been codified in 23 CCR §2910. The Enforcement Policy promotes a fair, firm, and consistent enforcement approach appropriate to the nature and severity of a violation.

5.3 COMPLIANCE WITH THE NON-POINT SOURCE POLICY

The *Policy for the Implementation and Enforcement of the Nonpoint Source Pollution Control Program* was adopted by the State Water Board on May 20, 2004. As explained in the Policy, the *Plan for California's Nonpoint Source Pollution Control Program* is to be implemented and enforced through California Water Code mandates and authorities, outreach, education, technical assistance, financial incentives, and collaborative efforts with other agencies and non-governmental organizations. The Policy formally eliminates the previous "three-tiered approach" of self-determined implementation of management measures, regulatory-based encouragement, and enforcement.

The Policy states that all current and proposed non-point source discharges must be regulated under waste discharge requirements (WDRs), waivers of WDRs, a basin plan prohibition, or some combination of these administrative tools. The Scott River TMDL Action Plan is in compliance with the Policy as the implementation actions described in this Chapter regulate and address non-point sources of sediment waste loads and elevated water temperatures through WDRs, waivers of WDRs, or some combination thereof.

5.3.1 Non-Point Source Pollution Control Implementation Programs and the Five Key Elements

The Policy describes a non-point source pollution control implementation program as a program developed to comply with WDRs, waivers of WDRs, or basin plan prohibitions. In regards to the Scott River TMDL Action Plan, a non-point source pollution control implementation program may take the form of an Erosion Control Plan, a Grazing and Riparian Management Plan, WDRs, waiver of WDRs, or some combination thereof.

The Policy requires that a non-point source pollution control implementation program include five key elements as simplified in Table 5.11. The first four key elements are the responsibility of the discharger and are to be described in their Erosion Control Plan, Grazing and Riparian Management Plan, WDRs, or waiver of WDRs. The fifth key element, to make clear the potential consequences for failure to achieve a non-point source pollution control program's stated purposes, is the responsibility of the Regional Water Board. Should a program's stated purpose(s) not be attained, the Regional Water Board and staff shall take appropriate enforcement actions. Enforcement actions shall be consistent with the State Water Board's

Water Quality Enforcement Policy (SWRCB Resolution No. 2002-0040), adopted February 19, 2002, and as it may be amended from time to time. This enforcement policy promotes a fair, firm, and consistent enforcement approach appropriate to the nature and severity of a violation.

Table 5.11
Summary of the Five Key Elements of the Policy for the Implementation and Enforcement of the Nonpoint Source Pollution Control Program

Key Element 1	The non-point source pollution control program's ultimate purpose shall be explicitly stated.
Key Element 2	A description of management practices and other program elements that are expected to be implemented to ensure attainment of the purpose shall be included.
Key Element 3	When it is necessary to allow time to achieve water quality requirements, a specific time schedule and milestones shall be included.
Key Element 4	Sufficient feedback mechanisms shall be included.
Key Element 5	The potential consequences for failure shall be included.

CHAPTER 6. MONITORING

Key Points

- There are several different types of monitoring, including implementation monitoring, upslope effectiveness monitoring, instream effectiveness monitoring, and compliance and trend monitoring.
- Monitoring may be required in conjunction with existing and/or proposed human activities that will likely result in sediment waste discharges or elevated water temperatures.
- Regional Water Board staff shall develop a compliance and trend monitoring plan within one year of the date the Scott River TMDL Action Plan takes effect.
- Monitoring requirements are specifically incorporated into the proposed Memoranda of Understanding with the County of Siskiyou, the U.S. Forest Service, and the U.S. Bureau of Land Management.

The purpose of this chapter is to describe the types of monitoring applicable to the Scott River watershed and describe the monitoring requirements of the Scott River TMDL Action Plan.

6.1 TYPES OF MONITORING

Monitoring can take several different forms, have different objectives, and yet be called, ubiquitously, monitoring. Consistent nomenclature is necessary for clarity. Different types of monitoring are described in this section.

6.1.1 Implementation Monitoring

Implementation monitoring assesses whether activities and control practices were carried out as planned. This type of monitoring can be as simple as photographic documentation, provided that the photographs are adequate to represent and substantiate the implementation of control practices. Implementation monitoring is a cost-effective type of monitoring because its purpose is to demonstrate that sediment control practices were properly installed and operated. On its own, however, implementation monitoring cannot directly link management activities to water quality, as no water quality measurements are made.

6.1.2 Upslope Effectiveness Monitoring

Upslope effectiveness monitoring is intended to determine, by assessing upslope conditions, if control practices are effective at keeping the pollutant from being discharged to a water body. In other words, it is ". . .used to evaluate whether the specified activities had the desired effect" (Solomon, 1989, as cited in MacDonald, 1991, p. 7). This type of monitoring can be as simple as photographic documentation, provided that the photographs are adequate to represent and substantiate that the control practices are effective.

6.1.3 Instream Effectiveness Monitoring

Instream effectiveness monitoring is intended to determine, by assessing instream conditions, if control practices are effective at keeping the pollutant from being discharged to a water body. In regards to sediment waste discharges, for example, this type of monitoring may involve the use of visual observations, limited instream habitat monitoring of salmonid freshwater habitat parameters, and/or grab samples for turbidity and suspended sediment in the water column. Instream effectiveness monitoring may be conducted upstream and downstream of the discharge point or before, during, and after the implementation of control practices. Development of an instream effectiveness monitoring program is site-specific and may include, where appropriate, partnerships between landowners and state and federal agencies.

6.1.4 Compliance & Trend Monitoring

Compliance and trend monitoring is intended to determine, on a watershed scale, if water quality objectives are being met, if TMDLs are being met, and if beneficial uses are being protected from the adverse effects of one or more pollutants.

Different sources refer to this type of monitoring as either compliance monitoring or trend monitoring. For example, MacDonald et al. (1991) states that compliance monitoring is ". . . the monitoring used to determine whether specified water quality criteria are being met" (p. 7). The California Department of Forestry (CDF) and the Regional Water Boards across the State have developed general water quality monitoring conditions that use trend monitoring for monitoring "typically applied at a watershed scale, focusing on the combined effects of all watershed management activities for multiple years. Examples of Trend Monitoring objectives include . . . [determining] whether Basin Plan water quality standards are achieved and maintained over time" (Fitzgerald, 2004). In reality, monitoring for compliance with water quality objectives, TMDLs, and beneficial uses will produce data that is useful for analyzing trends in water quality. Therefore, Regional Water Board staff call this monitoring requirement "Compliance & Trend Monitoring."

The extent and degree of compliance monitoring will vary depending on the site, local conditions, land ownership patterns, and the extent of land management activities in an area. In regards to sediment waste discharges, for example, compliance monitoring may involve the use of (1) wet weather turbidity, suspended sediment, and stream flow monitoring using a near-constant reading turbidimeter (sample taken once every fifteen minutes) and suspended sediment grab samples; and (2) salmonid freshwater habitat monitoring.

6.2 MONITORING REQUIREMENTS

6.2.1 General Monitoring Requirements

Each of the above types of monitoring is important for determining the overall success of the TMDL Action Plan in achieving sediment and temperature water quality standards. Therefore, monitoring shall be conducted upon the request of the Regional Water Board's Executive Officer in conjunction with existing and/or proposed human activities that will result or likely result in sediment waste discharges and/or elevated water temperatures within the Scott River watershed. Monitoring may involve implementation, upslope effectiveness, instream effectiveness, and/or compliance and trend monitoring. The authority for such requirements is contained in Section 13267 of the California Water Code, which states that the Regional Water Board may require any discharger, suspected discharger, or future discharger to furnish monitoring program reports.

The Executive Officer will base the decision to require monitoring on site specific conditions, the size and location of the discharger's ownership, and/or the type and intensity of land uses being conducted or proposed by the discharger. The decision will also be based on the control practices selected by the discharger. For example, if a discharger selects proven, established control practices, then instream effectiveness monitoring is less likely to be required. Conversely, if a discharger selects control practices that are not proven and are not known to provide protection against discharges, than there is a higher likelihood that instream effectiveness will be required.

If monitoring is required, the Executive Officer may direct the discharger to develop a monitoring plan and may describe specific monitoring requirements to include in the plan. Such requirements may include:

- parameter(s) to monitor (e.g., turbidity, sediment substrate composition, water temperature, percent shade, etc.);
- procedure (e.g., visual observations, grab samples, near-constant sampling, etc.);
- technique (e.g., sample upstream and downstream of the discharge point, sample before, during, and after the implementation of a control practice, etc.);
- location(s);
- frequency (i.e., how often will a sample be collected);
- duration (i.e., how long will the sampling occur);
- quality control and quality assurance protocols; and/or
- reporting requirements.

Monitoring parameters may include any of the instream or watershed indicators presented in Chapter 2, as appropriate. With all types of monitoring, Regional Water Board staff will provide technical assistance as staff resources allow. Additionally, monitoring data collected by the Regional Water Board or by responsible parties as required by the Executive Officer shall be made publicly available. Where staff resources allow, data and analysis results should be organized and assembled in an easily accessible and understandable manner, perhaps through of use of existing databases such as the Klamath Resource Information System.

6.2.2 Compliance and Trend Monitoring Requirements

Compliance and trend monitoring is a valuable and necessary element of any strategy to restore and attain water quality standards. The data gathered from compliance and trend monitoring provides dischargers and the Regional Water Board with the information needed to determine if the requirements of the TMDL Action Plan are improving the quality and quantity of instream salmonid habitat, and thusly, if the TMDL Action Plan as a whole, is effective at achieving water quality objectives, achieving the TMDLs, and protecting the beneficial uses.

In order to gather adequate instream monitoring data and draw valid conclusions, it is necessary for instream monitoring to be well planned for and thought out. Therefore, Regional Water Board staff shall develop a compliance and trend monitoring plan designed to provide feedback on the effectiveness of the TMDL Action Plan. Regional Water Board staff shall complete the monitoring plan within one year from the date the Scott River TMDL Action Plan takes effect.

The compliance and trend monitoring plan should include a detailed description of:

- monitoring goals and objectives,
- the parameters to be monitored,
- monitoring procedures and techniques,
- the locations of trend monitoring stations,
- monitoring frequency and duration,
- quality control and quality assurance protocols,
- benchmark conditions where available,
- data management procedures,
- data and analysis distribution procedures,
- measurable milestones, and
- specific due dates for monitoring and data analysis.

Monitoring parameters may include any of the instream or watershed indicators presented in Chapter 2, as appropriate. Due to the complexity and expense of compliance and trend monitoring, Regional Water Board staff shall attempt to work cooperatively with other agencies and organizations to develop the plan and conduct monitoring. In particular, Regional Water Board staff shall attempt to coordinate efforts with the Scott River Watershed Council (SRWC), the USFS, USFWS, DWR, and any other agencies or organizations already collecting data in the watershed. The SRWC, as described in the Strategic Action Plan (SRWC, 2004), is engaged in a pro-active monitoring effort designed to establish baseline information in the Scott River watershed by describing current conditions both quantitatively and qualitatively so that restoration needs can be identified and projects prioritized. Although the SRWC's objective is different from the compliance and trend monitoring objectives desired by Regional Water Board staff, it is possible to coordinate the two monitoring efforts. For example, where appropriate, the same monitoring sites can be used for both efforts, the same parameters and protocols can be employed, and data may be applicable to both efforts.

The Scott River Watershed Council Monitoring Plan (SRWC, 2004, Appendix M) provides definitions, methods, and protocols for various monitoring efforts. Methodologies have been established for the monitoring of fish habitat; fish populations; channel conditions through bank stability surveys and channel typing; water temperature; flow; instream sediment levels through V*, McNeil sampling, pebble counts, and turbidity sampling; macroinvertebrate populations; riparian conditions through photo-point monitoring; and restoration project effectiveness through photo-point monitoring. The SRWC also intends to establish and carry out quality assurance and quality control procedures, establish a monitoring database, analyze data, and report on conditions.

6.2.3 Monitoring Requirements Specific to the County of Siskiyou, USFS, and BLM

Monitoring requirements are specifically addressed and incorporated into the proposed Memorandum of Understanding for the County of Siskiyou in regards to county roads (Section 5.1.4), for the USFS (Section 5.1.11), and for the BLM (Section 5.1.12). For each of these entities, the requirements are primarily for implementation monitoring and upslope effectiveness monitoring.

6.2.4 Monitoring Requirements Specific to the Erosion Control Plans and Grazing and Riparian Management Plans

Implementation monitoring and upslope effectiveness monitoring will also likely be required of those landowners/dischargers who are required to develop and implement an Erosion Control Plan (Section 5.1.2) and/or a Grazing and Riparian Management Plan (Section 5.1.13). Implementation and upslope effectiveness monitoring in such instances will generally involve photographic documentation over time (i.e., photo-point monitoring) of sediment discharge sites, riparian vegetation conditions, and/or control practices.

CHAPTER 7. REASSESSMENT

Key Points

- The Regional Water Board is likely to reassess the Scott River TMDL Action Plan every three years during the Basin Planning Triennial Review process.
- Regional Board staff will report to the Board at least yearly on status and progress.
- Actions relying on encouragement will be evaluated for effectiveness no more than 5 years after approval of the TMDL.
- The Regional Water Board will conduct a more extensive and focused reassessment after the Scott River TMDL Action Plan has been in effect for ten years, or sooner, if the Regional Water Board determines it necessary..

This chapter describes the process the Regional Water Board will take to review, reassess, and possibly revise the TMDL Action Plan for the Scott River watershed.

The Regional Water Board is likely to reassess the TMDL Action Plan every three years during the Basin Planning Triennial Review process. Regional Board staff will prepare a yearly workplan describing key goals and activities with respect to the Action Plan. Regional Board staff will report to the Regional Board at least yearly on the status and progress of implementation activities. For activities that rely on encouragement as a first step, a formal assessment of proven or expected effectiveness of these efforts will be completed within 5 years from the date of U.S. EPA approval. An extensive and focused reassessment will occur after the TMDL Action Plan has been in effect for ten years. If the Regional Water Board determines it to be necessary, reassessment will occur before ten years has passed.

During the reassessments, the Regional Water Board is likely to consider the effectiveness of the TMDL Action Plan at meeting the sediment and temperature TMDLs, achieving sediment and temperature water quality objectives, and protecting the beneficial uses of the Scott River watershed. In order to help determine the effectiveness of the TMDL Action Plan, the Regional Water Board and staff will ask a series of questions. These questions are listed below in Table 7.1, along with possible approaches to answering the questions, and steps to take if revision is found to be necessary.

Although the Regional Water Board and staff will attempt to answer the questions listed in Table 7.1 while conducting the reassessments, it is important to note that the questions and possible revisions are not requirements of the Regional Water Board. It may not be feasible to fully assess the TMDL Action Plan due to limited resources or data. For example, the amount of time and funding required to conduct a new sediment or temperature source analysis may not be available during reassessment.

Table 7.1
Reassessment Considerations

Topic	Questions to Ask During Reassessment	How to Answer the Question	Steps to Take if Revision is Necessary
Attainment of Objectives	Are sediment and temperature water quality objectives still not being met? Are the beneficial uses associated with the cold water salmonid fishery still negatively impacted by excessive sedimentation and high water temperatures? Are sediment waste discharges and elevated water temperatures still the cause of the reduction in quality and quantity of instream habitat capable of supporting salmonids and other beneficial uses? Are there other beneficial uses adversely affected by excess sedimentation and high water temperatures?	Review compliance and trend monitoring data, and any other valid, instream water quality and salmonid data. Review scientific research, data, and literature published since 2005.	If the answers are all no, the Scott River may be considered high quality waters. Delisting the River from the 303(d) List will likely be appropriate. Consider amending the Basin Plan to revise, lessen, and perhaps eliminate sediment and temperature control requirements. Consider amending the Basin Plan to relax sediment and temperature control requirements. If any answer is yes, consider amending the Basin Plan to increase and tighten sediment and temperature control requirements. Consider requiring Erosion Control Plans and/or Grazing and Riparian Management Plans from more dischargers.
Attainment of TMDLs	Are the TMDLs still not being attained?	Calculate the current sediment load. Calculate the current effective shade.	If the answer is no, staff should consider attainment of water quality objectives. See above. If any answer is yes, consider amending the Basin Plan to increase and tighten sediment and temperature control requirements. Consider requiring Erosion Control Plans and/or Grazing and Riparian Management Plans from more dischargers.
Desired Conditions	Are the desired conditions no longer appropriate? Are there any parameters that should be added, revised, or removed?	Review scientific research, data, and literature published since 2005.	If the answer is yes, consider amending the Basin Plan to update the desired conditions.
Desired Conditions	Are the monitoring and sampling requirements still accurate and understandable?	Review scientific research, data, and literature published since 2005. Consider monitoring experiences.	If the answer is no, consider developing a monitoring and sampling guidance document that is separate but supplemental to the TMDL Action Plan.
Sediment Source Analysis	Are the sources identified in the Sediment Source Analysis still accurate?	Review Erosion Control Plans, timber harvest plans, Grazing and Riparian Management Plans, Memoranda of Understanding, and waste discharge requirements. Review scientific research, data, and literature published since 2005. Conduct a new sediment source analysis.	If the answer is no, consider amending the Basin Plan to update the sediment source analysis. Consider revising the TMDL and load allocations.

Topic	Questions to Ask During Reassessment	How to Answer the Question	Steps to Take if Revision is Necessary
Temperature Source Analysis	Are the sources identified in the Temperature Source Analysis still accurate?	Review timber harvest plans, Grazing and Riparian Management Plans, Memoranda of Understanding, and waste discharge requirements. Review scientific research, data, and literature published since 2005. Conduct a new temperature source analysis.	If the answer is no, consider amending the Basin Plan to update the temperature source analysis. Consider revising the TMDL and load allocations.
TMDL	Are the TMDLs accurate?	Review scientific research, data, and literature published since 2005. Conduct new source analyses.	If the answer is no, consider amending the Basin Plan to update the TMDL(s). Consider revising the load allocations.
Load Allocations	Are the load allocations accurate?	Review scientific research, data, and literature published since 2005. Conduct new source analyses and rework the TMDL calculations.	If the answer is no, consider amending the Basin Plan to update the load allocations.
Implementation	Are the requirements clear and easily understandable by the regulated dischargers?	Consult with dischargers. Consult with other agencies involved with the TMDL Action Plan.	If the answer is no, consider developing a guidance document. Consider amending the Basin Plan to revise unclear or confusing language.
Implementation – Water Temperature	Are sources of elevated water temperatures effectively being prevented, minimized, and controlled?	Review Grazing and Riparian Management Plans, timber harvest plans, waste discharge requirements, and monitoring data.	If the answer is no, consider requiring more landowners/dischargers develop and implement Riparian and Grazing Management Plans. Consider increasing the number of waste discharge requirements and/or enforcement actions on activities that remove shade-producing vegetation. Consider amending the Basin Plan to add a prohibition against the remove and/or suppression of vegetation that provides shade to a water body in the Scott River watershed.
Implementation – Sediment Discharges	Are existing sediment waste discharges effectively being prevented, minimized, and controlled?	Review Erosion Control Plans and instream monitoring data.	If the answer is no, consider requiring more landowners/dischargers develop and implement Erosion Control Plans. Consider amending the Basin Plan to increase and tighten sediment control requirements.
Implementation – Grazing Activities	Are sediment waste discharges and elevated water temperatures caused by grazing activities being prevent, minimized, and controlled?	Review Grazing and Riparian Management Plans and instream monitoring data.	If the answer is no, consider requiring more landowners/dischargers develop and implement Grazing and Riparian Management Plans. Consider amending the Basin Plan to increase grazing related implementation actions.
Implementation – Flood Control & Bank Stabilization	Are dredge, fill, and bank stabilization projects causing elevated water temperatures?	Review 401 Certification permits issued since 2005. Review instream monitoring data.	If the answer is yes, consider waste discharge requirements for such activities.

Topic	Questions to Ask During Reassessment	How to Answer the Question	Steps to Take if Revision is Necessary
Implementation – Scott River Watershed Council	Have the strategic actions described in the Strategic Action Plan (SRWC, 2004) been effective at preventing, minimizing, and controlling sediment waste discharges and elevated water temperatures?	Review the SRWC's effectiveness monitoring data. Review available compliance and trend monitoring data. Conduct sediment and temperature source analyses.	If the answer is no, consider revising strategic actions. Consider requiring landowners/dischargers to implement appropriate sediment and temperature control practices.
Implementation – Water Use	Has the County of Siskiyou developed a study plan to study the connection between groundwater and surface water, the impacts of groundwater use on surface flow and beneficial uses, and the impacts of groundwater levels on the health of riparian vegetation in the Scott River watershed? Has the study been conducted, or is it being conducted?	Consult with the County of Siskiyou and other appropriate stakeholders.	If the answer is no, discuss delays with the County of Siskiyou and attempt to remedy any problems. Consider requesting the State Water Resources Control Board to develop the study plan and/or conduct the study.
Monitoring	Is there enough information available to determine if sediment waste discharges and sources of elevated water temperatures are being controlled?	Review submitted and available monitoring data.	If the answer is no, consider requiring more monitoring and the submission of monitoring reports and data.
Monitoring - Upslope & Instream Effectiveness	Is there enough information available to determine if sediment and temperature control practices are effective?	Review submitted and available monitoring data associated with upslope and instream effectiveness monitoring.	If the answer is no, consider requiring more effectiveness monitoring and the submission of monitoring reports and data.
Monitoring - Compliance & Trend	Is there enough information available to determine if the quality and quantity of instream salmonid habitat is improving?	Review submitted and available monitoring data associated with instream effectiveness monitoring and compliance and trend monitoring.	If the answer is no, consider requiring more compliance and trend monitoring and the submission of monitoring reports and data. Consider funding more monitoring stations.

CHAPTER 8. ANTIDEGRADATION ANALYSIS

Key Points

- The state and federal antidegradation policies require, in part, that where surface waters are of higher quality than necessary to protect beneficial uses, the high quality of those waters must be maintained unless otherwise provided by the policies.
- The federal antidegradation policy prohibits any activity or discharge that would lower the quality of surface water that does not have assimilative capacity with limited exceptions as set forth in the federal regulations.
- The Scott River TMDL Action Plan is based, in part, on the principles contained in the state and federal antidegradation policies.
- The Scott River TMDL Action Plan will result in water quality improvement; therefore, state and federal antidegradation analyses are not required.

This chapter briefly describes the state and federal antidegradation policies and how they apply to the Scott River TMDL Action Plan.

8.1 STATE & FEDERAL ANTIDEGRADATION POLICIES

The state and federal antidegradation policies are independently enforceable requirements, despite being referred to as policies. The state antidegradation policy is titled the *Statement of Policy with Respect to Maintaining High Quality Waters in California*, codified in 23 CCR §2900, and is commonly known as "Resolution 68-16." The federal antidegradation policy is found at 40 CFR §131.12. Both polices have been incorporated into the Basin Plan.

Although there are some differences, where the state and federal policies overlap they are consistent with each other. Both the state and federal antidegradation policies require that where surface waters are of higher quality than necessary to protect the designated beneficial uses, the high quality of those waters be maintained unless otherwise provided by the policies. Both policies require that certain findings be made before any adverse change to water quality can be permitted. The State Water Board has concluded that Resolution No. 68-16 incorporates the federal Antidegradation Policy (see State Water Board Order No. WQ 2001-16, p. 19, fn 83).

The state antidegradation policy applies to groundwater and surface water whose quality meets or exceeds water quality objectives. The state policy establishes a two-step process to determine if discharges that will degrade water quality are allowed. The first step requires that where a discharge will degrade high quality water, the discharge may be allowed if any change in water quality:

1. Will be consistent with the maximum benefit to the people of the state,
2. Will not unreasonably affect present and anticipated beneficial uses of such water, and
3. Will not result in water quality less than that prescribed (e.g., by water quality objectives).

The second step is that any activities that result in discharge to high quality waters are required to use the best practicable treatment or control necessary to avoid a pollution or nuisance and to maintain the highest water quality consistent with the maximum benefit to the people of the state. The state antidegradation policy further establishes that if the discharge, even after treatment, unreasonably affects beneficial uses or does not comply with applicable provisions of Basin Plans, the discharge would be prohibited.

The federal antidegradation policy applies to surface water regardless of the quality of the water. In allowing an activity to degrade or lower water quality, the federal antidegradation policy requires states to ensure that:

1. The activity is necessary to accommodate important economic or social development in the area,
2. Water quality is adequate to protect and maintain existing beneficial uses fully, and
3. The highest statutory and regulatory requirements and best management practices for pollution control are achieved.

The federal antidegradation policy also applies to surface waters that do not meet the applicable water quality objectives (i.e., impaired waters). Under the federal policy, an activity or discharge would be prohibited if the activity will lower the quality of surface water that does not have assimilative capacity (i.e., the water quality is not sufficient to support designated beneficial uses) with limited exceptions set forth in federal regulations.

Both the state and federal antidegradation policies acknowledge that minor or repeated activities, even if individually small, can result in violation of antidegradation policies through cumulative effects, especially, for example, when the waste is a cumulative, persistent, or bioaccumulative pollutant.

8.2 APPLICABILITY TO THE SCOTT RIVER TMDL ACTION PLAN

The proposed Scott River TMDL Action Plan is based in part on the principles contained in the state and federal antidegradation policies. The recommended alternative – adoption of the proposed Scott River TMDL Action Plan and adoption of the proposed introductory summary of TMDLs – will not delete or limit beneficial use designations and will not relax any water quality standard. This proposal will result in water quality improvements; therefore, state and federal antidegradation analyses are not required.

CHAPTER 9. ENVIRONMENTAL ANALYSIS

Key Points

- For the purposes of the California Environmental Quality Act (CEQA), the proposed project consists of:
    - Adoption of the Scott River TMDL Action Plan as a Basin Plan amendment.
    - Adoption of the introductory summary of TMDLs as a Basin Plan amendment.

- The project is categorically exempt from the provisions of CEQA that require an initial study, environmental impact report, and a negative declaration.

- Other relevant provisions of CEQA and State Water Board regulations require that amendments to a Basin Plan comply with the functionally equivalent process, including:
    - holding a scoping meeting,
    - preparation of a functionally equivalent substitute document,
    - preparation of alternatives to the project,
    - preparation of a CEQA Checklist,
    - preparation of an analysis of environmental impacts, and
    - preparation of mitigation measures.

- A properly noticed CEQA Scoping Meeting was held on June 28, 2005, in Yreka, CA.

- This Staff Report serves as the functionally equivalent substitute document.

- Three alternatives are considered:
    - Alternative 1: No Action.
    - Alternative 2: Scott River TMDL Action Plan as proposed.
    - Alternative 3: WDR-based Implementation Actions.

- Regional Water Board staff recommend Alternative #2.

- The CEQA Checklist is included as Appendix E.

- This chapter serves as the analysis of environmental impacts.

- The adoption of the proposed Scott River TMDL Action Plan and the proposed introductory summary of TMDLs will <u>not</u> have a significant impact on the environment because the term “significant impact” is defined to include only adverse impacts. The environmental changes that will result from the proposed project are beneficial, not adverse.

- A description and analysis of mitigation measures is not required because there are no significant adverse impacts to be mitigated.

For the purposes of the California Environmental Quality Act (CEQA), the project consists of:

1. Adoption of the proposed Scott River TMDL Action Plan as a Basin Plan amendment.
2. Adoption of the proposed introductory summary of TMDLs as a Basin Plan amendment.

The adoption of the proposed Scott River TMDL Action Plan and the adoption of the proposed introductory summary of TMDLs will not have a "significant impact on the environment," because that term is defined to include only adverse impacts (14 CCR §15382). The environmental changes that will result from the proposed project are beneficial, not adverse. These statements are supported by the CEQA Checklist (Appendix E) and by the information presented in this Staff Report.

9.1 ENVIRONMENTAL ANALYSIS REQUIREMENTS

The adoption of the proposed Scott River TMDL Action Plan and the adoption of the proposed introductory summary of TMDLs constitute an action taken by a regulatory agency that is categorically exempt from certain provisions of CEQA, including the necessity to prepare an initial study, an environmental impact report (EIR), and a negative declaration. Two exemptions are applicable:

- <u>Class 7 Exemption for Actions by Regulatory Agencies for Protection of Natural Resources</u>
  "Class 7 consists of actions taken by regulatory agencies as authorized by state law or local ordinance to assure the maintenance, restoration, or enhancement of a natural resource where the regulatory process involves procedures for protection of the environment. Examples include but are not limited to wildlife preservation activities of the state Department of Fish and Game. Construction activities are not included in this exemption" (14 CCR §15307).

- <u>Class 8 Exemption for Actions by Regulatory Agencies for Protection of the Environment</u>
  "Class 8 consists of actions taken by regulatory agencies, as authorized by state or local ordinance, to assure the maintenance, restoration, enhancement, or protection of the environment where the regulatory process involves procedures for protection of the environment. Construction activities and relaxation of standards allowing environmental degradation are not included in this exemption" (14 CCR §15308).

The project – adoption of the proposed Scott River TMDL Action Plan and the proposed introductory summary of TMDLs – is consistent with these exemptions as the project will not have a significant adverse effect on the environment.

Other relevant portions of CEQA continue to apply, and State Water Board regulations require amendments to a Basin Plan to comply with a functional equivalent process. As part of this process, a Basin Plan amendment must include:

- Solicitation of public input, including holding a scoping meeting to assess the potential environmental scope of the CEQA analysis.
- The preparation of a functionally equivalent substitute document.

- The preparation of alternatives to the project.
- The preparation of a CEQA Checklist
- The preparation of an analysis of environmental impacts.
- The preparation of mitigation measures.

The project has met these requirements. More information on these requirements are included in the following sections.

9.2 SCOPING MEETING

The CEQA Scoping Meeting was held on June 28, 2005, in Yreka, California. A public notice of the meeting was sent out on May 13, 2005. Triplicate notices were inserted in newspapers throughout the North Coast Region beginning the week of May 15, 2005. In preparation for the Scoping Meeting, a plain English summary of the proposal was made available to interested parties and was posted on the North Coast Region website.

Many of the comments received at the CEQA Scoping meeting concerned technical aspects of the initial proposal rather than the scope of the environmental review. The comments received at the CEQA Scoping Meeting that concerned the scope of the environmental review are summarized in Table 9.1 below. These comments, and others, helped to shape the scope of the environmental review and specific aspects of the resulting proposal.

9.3 FUNCTIONALLY EQUIVALENT SUBSTITUTE DOCUMENT

As discussed previously in this Staff Report, the Basin Plan amendment process has been certified by the Secretary for Resources as functionally equivalent to, and therefore exempt from, the CEQA requirement for preparation of an environmental impact report (EIR) or negative declaration and initial study (14 CCR §15251(g)). A substitute document that is functionally equivalent to an EIR or negative declaration must be prepared, and must include a description of the proposed project and either a description of alternatives with mitigation measures to avoid significant adverse impacts or a statement showing that the project would have no significant adverse impacts. This entire Staff Report serves as the functionally equivalent substitute document. It contains the required elements.

9.4 ALTERNATIVES & STAFF RECOMMENDATION

This section identifies and analyzes reasonable alternatives to the recommended approach that address different ways to reduce sediment waste discharges and elevated water temperatures in the Scott River watershed. An analysis of reasonable alternatives is required by CEQA. Every conceivable alternative need not be considered – only those that would meet the project objectives and are reasonable. "The range of potential alternatives to the proposed project shall include those that could feasibly accomplish most of the basic objectives of the project and could avoid or substantially lessen one or more of the significant effects" (14 CCR §15126.6(a)).

Table 9.1 Comments & Responses from the CEQA Scoping Meeting		
Scoping Factor	**Comment**	**Response**
Aesthetics	No Comments.	N/A
Agricultural Resources	Proposed project could result in conversion of farmland, to non-agricultural uses because the requirements will be so stringent that rural landowners will have to sell land for development.	No specific information was presented to demonstrate that the proposal was overly stringent. The information presented in this Staff Report indicates that the proposed implementation actions are not overly stringent. The proposal is authorized and required by existing state and federal laws. The Regional Water Board will work with landowners to develop inventories and help fund projects for cooperative landowners. The public will have time to come up with acceptable implementation alternatives. Landowner income and ability, as well as the source of problems will all be factored into specific time tables and practices to control sediment inputs and impacts to water temperatures. The time frame for implementing the TMDL is long. For example, 40 years would be a typical timeframe to achieve the TMDLs.
Air Quality	No Comments.	N/A
Biological Resources	No Comments.	N/A
Cultural Resources	No Comments.	N/A
Geology and Soils	No Comments.	N/A
Hazards and Hazardous Materials	No Comments.	N/A
Hydrology and Water Quality	Increasing riparian vegetation may reduce instream water flows.	While this may be true in the short term, in the long term, increasing riparian vegetation can raise the water table thus increasing groundwater inputs. Additionally, staff is discussing the restoration of vegetation to natural levels only. More study is proposed to address this issue.
Land Use and Planning	Look at the effects of duplication of programs.	Duplication of efforts and overlap of regulatory programs is addressed in this Staff Report.
Mineral Resources	No Comments.	N/A
Noise	No Comments.	N/A
Population & Housing	No Comments.	N/A
Public Services	No Comments.	N/A
Recreation	No Comments.	N/A
Transportation and Traffic	No Comments.	N/A
Utilities and Service Systems	No Comments.	N/A

Factors that can be used to determine the feasibility of alternatives include: economic, social, environmental, legal, and technical. The analysis of alternatives must “include sufficient information about each alternative to allow meaningful evaluation, analysis, and comparison with the proposed project” (14 CCR §15126.6(d)).

In order to meet the project objectives, the selected alternative must provide the tools necessary to effectively control sediment waste discharges and elevated water temperatures across the Scott River watershed so that the TMDLs are achieved, beneficial uses are protected, temperature and sediment-related water quality objectives are attained, and water quality is preserved, enhanced, and restored. Each alternative is analyzed to determine potential consequences and how that alternative would or would not achieve the stated goals.

The following alternatives were considered:

Alternative 1	No Action.
Alternative 2	Scott River TMDL Action Plan as proposed.
Alternative 3	WDR-based Implementation Actions.

9.4.1 Alternative 1: No Action

The no action alternative retains the existing Basin Plan language and does not result in the proposed Basin Plan amendment.

Currently, the Scott River watershed is not meeting water quality objectives as set out in the Basin Plan for the North Coast Region. Section 303(d) of the federal Clean Water Act requires that a list be developed of all impaired or threatened waters within each state. The Scott River watershed is listed as impaired on the 303(d) list, as described in Chapters 1 and 2 of this Staff Report. The watershed is not only listed as impaired on the federal 303(d) list, but the listings have been confirmed by monitoring and data evaluation. Section 303(d) also requires that each state establish a total maximum daily load (TMDL) for any water body designated as water quality limited. A TMDL is the maximum amount of a pollutant that a water body can contain and still achieve water quality standards. When TMDLs are adopted into the Basin Plan, they must contain implementation strategies that establish how water bodies will attain and maintain water quality objectives and support designated beneficial uses.

The Regional Water Board has entered into an agreement with the U.S. EPA to complete a full TMDL action plan by a court ordered consent decree due date.[1] As part of this agreement, the U.S. EPA provides funding to the Regional Water Board. Under the no action alternative, a full and complete TMDL action plan will not be adopted and the U.S. EPA will be forced to establish the technical TMDLs for sediment and temperature by the consent decree due date. Technical TMDLs established by the U.S. EPA lack implementation strategies, monitoring plans, reassessment strategies, antidegradation analyses, environmental analyses, and economic analyses. Without a comprehensive TMDL action plan, and an implementation strategy in

[1] Pacific Coast Federation of Fishermen’s Associations, et al. v. Marcus, No. 95-4474 MHP, 11 March 1997.

particular, achievement of the TMDLs, attainment of water quality standards, and protection of the beneficial uses of the Scott River is not likely to occur.

The no action alternative is technically feasible and does not require any change to the Basin Plan. This alternative, however, has already been demonstrated to be ineffective at controlling excess sediment waste discharges and increased water temperatures in the Scott River watershed. Selecting the no action alternative would not result in any increased regulatory or economic burden to dischargers, however, the economic impacts of not addressing water quality impairments would be continued. The consequences of selecting this alternative may be the continued degradation of water quality and adverse impacts to beneficial uses with the attendant direct and indirect costs, such as the increased need for dredging, increased costs for water treatment, reduced commercial, recreational and subsistence fisheries, and increased flooding.

9.4.2 Alternative 2: Scott River TMDL Action Plan

This alternative consists of amending the Basin Plan to add the Scott River TMDL Action Plan and introduction summary of TMDLs as proposed.

The Regional Water Board identified excessive sediment and elevated water temperatures as water quality problems in the Scott River watershed, and the watershed is listed as impaired on the federal 303(d) list. The Regional Water Board is obligated to complete TMDLs in the Scott River watershed in compliance with a schedule agreed to with the U.S. EPA in order to meet the completion date under a court ordered consent decree arising from the lawsuit of Pacific Coast Federation of Fishermen's Associations v. Marcus, as described in the previous section. To meet this schedule, the Scott River TMDLs must be completed and adopted into the Basin Plan in 2006.

The goal of the proposed Basin Plan amendment is to establish the TMDL and describe the implementation actions necessary to achieve the TMDLs and attain water quality standards, including protecting the beneficial uses of water. The amendment does this by addressing the sediment and temperature impairments in the Scott River watershed specifically through implementation actions. The proposed implementation actions describe the steps that are necessary to prevent, minimize, and control sources of sediment waste discharges and elevated water temperatures for significant sources and land uses. The implementation actions are tailored for individual sources and land uses. Several of the implementation actions outline a process for coordination between stakeholders while others describe the additional study needs. Other implementation actions focuses on permitting and enforcement tools.

The Scott River TMDL Action Plan must be adopted in order to preserve, enhance, and restore the Scott River watershed, support beneficial uses, and achieve and maintain water quality objectives. The result will be a proactive strategy to address sediment discharges and excess water temperatures resulting from land use activities conducted in the watershed.

9.4.3 Alternative 3: WDR-Based Implementation Actions

This alternative consists of amending the Basin Plan to add the introductory summary of TMDLs as proposed, the TMDLs as proposed (i.e., the sediment and temperature source analyses, TMDLs, load allocations, and margins of safety), and a suite of implementation actions that would vary from those currently proposed. Specifically, the implementation actions would be more regulatory in nature and rely on formal permit mechanisms to prevent, reduce, and control sediment waste discharges and elevated water temperatures in the Scott River watershed. The goals of such an alternate TMDL Action Plan would be the same: to achieve the TMDLs and attain water quality standards, including protecting the beneficial uses of water. This alternative would also meet Consent Decree deadlines.

As stated above, many of the implementation actions under this alternative would be more regulatory in nature then currently proposed in the Alternative #2. Formal permit mechanisms would be used. For example, permits in the form of waste discharge requirements (WDRs) or waivers of WDRs would be developed to address sediment waste discharges and elevated water temperatures. Road construction and maintenance activities, grading activities, activities that remove or suppress vegetation that provide shade to a water body, and grazing activities would be regulated under WDRs or waivers of WDRs.

This alternative would meet the objectives of the project by ensuring that sources of sediment waste and elevated water temperatures in the Scott River watershed are prevented, reduced, and controlled so as to meet the TMDLs and attain water quality standards. WDRs and waivers of WDRs would allow for specific requirements on an individual landowner basis or a general land use basis, and would also include specific time lines and monitoring requirements. This alternative would also likely increase the compliance cost to landowners/dischargers as WDRs require the submission of an annual fee to the State. This alternative may also result in additional adverse environmental consequences because of the delay imposed by the need to develop each WDR or waiver.

9.4.4 Staff Recommendation

Regional Water Board staff recommend Alternative #2 and the adoption of the Scott River TMDL Action Plan and introductory summary of TMDLs.

9.5 CEQA CHECKLIST

Following the CEQA Scoping Meeting, and the preparation of a specific proposal (the project), the CEQA Checklist was prepared. The CEQA Checklist is attached to this Staff Report as Appendix E.

9.6 ANALYSIS OF ENVIRONMENTAL IMPACTS

The project does not consist of any actual sediment-generating activities or activities that would adversely effect water temperature. The project establishes a Scott River TMDL Action Plan to control, limit, and reduce sediment discharges and impacts to water temperature from anthropogenic activities. The proposed requirements will be incorporated into permitting requirements and authorities, but the project does not permit such activities. The proposed project will not have a significant adverse impact to the environment. The proposed project will have a significant beneficial impact on the environment because it will reduce excess sedimentation of watercourses and reduce adverse impact of high water temperature in the Scott River Basin.

The adoption of the proposed Scott River TMDL Action Plan and the proposed introductory summary of TMDLs will <u>not</u> have a significant impact on the environment because the term "significant impact" is defined as an adverse impact with "… a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project, including land, air, water, minerals, flora, fauna, ambient noise, and objects of historic or aesthetic significance" (14 CCR §15382). The environmental changes that will result from the proposed project are beneficial, not adverse.

9.7 MITIGATION MEASURES

As described above, adoption of the proposed Scott River TMDL Action Plan and the proposed introductory summary of TMDLs will have a beneficial impact on the environment because it will reduce excess sedimentation and lower the temperature of waters of the state in the Scott River watershed. The environmental changes that will result from the proposed project are beneficial, not adverse. A description and analysis of mitigation measures is not required because there are no significant adverse impacts to be mitigated.

CHAPTER 10. ECONOMIC ANALYSIS

Key Points

- The Scott River TMDL Action Plan builds on ongoing voluntary efforts in the watershed, and implementation of existing regulatory requirements where voluntary efforts are insufficient or too slow. No new water quality objectives or prohibitions are established, and no new burdens are imposed on dischargers. The Plan is geared toward using ongoing efforts and existing regulatory standards and enforcement tools more effectively than in the past, using available watershed-specific information and applicable science to inform those efforts.

- The proposed Scott River TMDL Action Plan will therefore have no direct economic costs or benefits above and beyond those required by existing regulatory requirements except to the degree that existing authorities and obligations will be more effectively implemented and complied with under the Plan. Landowners and dischargers are already bound by various existing regulatory requirements that involve water quality and natural resource protection, and the economic impacts associated with existing obligations are not directly attributable to this Action Plan.

- There are no costs or benefits associated with encouragement of ongoing efforts.

- Compliance with existing regulatory requirements can have both positive and negative economic impacts. Costs and benefits associated with meeting existing requirements are included in this document for informational purposes.

- Positive impacts include benefits related to:
    - fishing, including commercial, subsistence, and cultural fishing;
    - flooding;
    - properly functioning ecosystems;
    - recreation;
    - remediation activities, including habitat restoration and road maintenance;
    - land values; and
    - water conveyance and storage facilities.

- Negative impacts include costs related to:
    - road maintenance and sediment waste discharges avoidance;
    - dredge mining implementation actions;
    - temperature and vegetation implementation actions;
    - water use implementation actions;
    - flood control and bank stabilization actions;
    - implementation actions for the USFS and BLM; and
    - grazing implementation actions.

- The costs and benefits will not be uniformly distributed throughout the watershed, or even across properties with similar land uses.

- Potential sources of financing include private financing as well as public monies available through grants and other public funding programs.

This chapter includes an analysis of the potential economic impacts, both positive and negative, from compliance with existing regulatory requirements as implemented through the the proposed Scott River TMDL Action Plan. Because the Action Plan does not include any new regulatory requirements, and relies in part on encouraging existing self-directed efforts in the watershed, there are no incremental positive or negative economic impacts directly attributable to this action. Nevertheless, to provide information on negative economic impacts, or costs, that could be incurred and positive economic impacts, or benefits, that may accrue as a result of compliance with existing regulatory requirements, this chapter provides information on both costs and benefits of compliance. The negative impacts relate to the costs of compliance and the costs of remediation. The positive economic impacts relate to both economic and non-economic values that will be improved by recovery of the watershed, high water quality, and supported beneficial uses.

Regional Water Board staff conclude that the estimated costs are existing obligations and therefore are not directly attributable to the proposed Scott River TMDL Action Plan, but that even if they were treated as new costs associated with the Plan, they are justified, not only because of the economic benefits that would be achieved, but also because of the legal obligations under which the Regional Water Board must act to protect water quality, beneficial uses, and the general public interest in fulfilling these obligations.

10.1 LEGAL FRAMEWORK

In amending the Basin Plan, the Regional Water Board must analyze the reasonably foreseeable methods of compliance with proposed performance standards and treatment requirements (Pub. Resources Code §21000 et seq.). This analysis must include economic factors, but does not require a cost-benefit analysis.

Additionally, in accordance with the Porter-Cologne Water Quality Control Act, it is the policy of the state to protect the quality of all waters of the state. Waters of the state include “any surface water or groundwater, including saline waters, within the boundaries of the state” (CWC §13050). When adopting the Porter-Cologne Act, the Legislature declared that all values of the water should be considered, but then went on to provide only broad, non-specific direction for considering economics in the regulation of water quality.

> “The Legislature further finds and declares that activities and factors which may affect the quality of the waters of the state shall be regulated to attain the highest water quality which is reasonable, considering all demands being made and to be

made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible" (CWC §13000).

The Porter-Cologne Act directed regulatory agencies to pursue the highest water quality that is reasonable, and *one* of the factors used to determine what is reasonable is economics. It is clear, though, that economic factors cannot be used to justify a result that would be inconsistent with the federal Clean Water Act or the Porter-Cologne Act. The Regional Water Board is obligated to restore and protect water quality and beneficial uses.

10.2 SCOPE OF THE ECONOMIC ANALYSIS

10.2.1 Existing Requirements

Landowners and dischargers are bound by various existing regulatory requirements that involve water quality and natural resource protection. The economic impact of existing obligations should not be attributed to the proposed Scott River TMDL Action Plan.
Applicable existing requirements include:

- Existing Basin Plan requirements (such as the sediment prohibition, the federal and state antidegradation policies, the controllable factors requirement, the general Waste Discharge Requirements and general waiver for timber harvest activities, and the existing water quality objectives for temperature, sediment, settleable material, suspended material, and turbidity).
- State nonpoint source program requirements.
- Porter-Cologne Act requirements (such as the requirement of Section 13260 for every person who discharges a waste that impacts water quality to file a report of waste discharge with the Regional Water Board, and the cleanup and abatement requirements of Section 13304).
- The California Department of Forestry and Fire Protection requirements for timber harvest activities.
- The federal and state endangered and threatened species requirements.
- Obligations imposed by other local, state and federal natural resource agencies.

There are no costs associated with encouragement of existing and ongoing activities in the watershed.

10.2.2 Geographic Scope

The costs and benefits of complying with existing regulatory requirements will not be uniformly distributed throughout the Scott River watershed. The implementation actions proposed by the Scott River TMDL Action Plan (see Chapter 5 of this Staff Report) are not uniformly required across the Scott River watershed or even across properties with similar land uses. Instead, many of the implementation actions will be required of landowners on an as-needed, site-specific basis or are simply activities that are encouraged by the Regional Water Board. While this flexibility adds greatly to the effectiveness of the Scott River TMDL Action Plan, it is one factor preventing this economic analysis from totaling benefits and cost on a watershed scale.

Additionally, more intensive land use activities will face greater costs than less intensive land use activities. Activities on steep, erosive slopes in proximity to water bodies will require greater care and higher costs than activities on lands that do not deliver to a water body or on lands that are not highly erosive.

10.3 BENEFITS

This section presents the estimated benefits of the complying with existing water quality requirements. These benefits relate to both economic and non-economic values that will be improved by recovery of the watershed, high water quality, and supported beneficial uses. Benefits also include avoiding costs associated with the impacts of current and expected sediment waste discharges and elevated temperatures if they are not prevented and controlled. Existing temperature and sediment impairment of beneficial uses negatively impact the cold water salmonid fishery (including the essential habitat of these fish), the fishing industry, water supplies, parks and the recreation industry, and others. The loss of soil from stream bank erosion and topsoil runoff for farming, grazing, and horticulture is another economic impact to agricultural industries.

Ribaudo (1989), an economist with the U.S. Department of Agriculture, studied water quality benefits related to prevention of soil erosion under the U.S.D.A. Conservation Reserve Program. He concluded that if sediment could be prevented from entering streams, the benefits to downstream landowners and water users would include actual benefits and avoided costs, such as lowered water treatment costs, reduced sediment removal costs, reduced flood damage, less damage to equipment that uses water, and increased recreational fishing. For the Pacific Region (including California), the amount calculated for sediment that could be prevented from entering streams was $2.48 per ton (in 1989 dollars). Not only was this amount calculated 16 years ago, but it does not even begin to address the impacts to commercial fishing, reduced road maintenance costs, the benefits of keeping soil in place and on-site to protect agricultural and silvicultural productivity, and protection of threatened and endangered species – all important in the Scott River watershed.

Although many of the economic benefits of complying with existing water quality requirements are foreseeable and describable, there is inadequate information to fully quantify some of these benefits. What information is available on benefits related to fishing, flooding, properly functioning ecosystems, recreation, remediation activities, residential land prices, and water conveyance and storage facilities are described in the following sections. These sections are organized alphabetically, and are not listed in order of importance or size of economic benefit.

10.3.1 Fishing – Commercial, Subsistence, & Cultural

Commercial commodity fishing has been adversely affected by the decline in fisheries stocks in recent years. Salmon, especially, have economic value to commercial, recreational, and cultural fishing activities. The financial losses of commercial fisheries are due to many factors beyond the impact of sediment and water temperature impaired habitat (including ocean harvest, water diversions, and other habitat impairments such as low dissolved oxygen), so the amount of the loss attributed to excess sediment and high water temperatures in the Scott River watershed has not been determined. However, the Coho Recovery Strategy extrapolates coho recovery benefits and concludes that the economic benefits of recovery would be greater than the costs:

> "Benefits associated with non-use values include intrinsic, or existence values which are derived from the knowledge that coho salmon populations exist, and bequest values which confer value to the resource for the benefit of future generations. Based on studies that examined streams in Colorado and salmon restoration in the Columbia River Basin, the San Joaquin River, and the Elwha River, the extrapolated value of California coho salmon recovery could be significantly larger than the fiscal or socioeconomic costs of recovery" (CDFG 2004).

In addition to the impact on the commercial fishery, fishing plays an important role in Native American cultures in the Klamath River to which the Scott River is tributary. Improved habitat resulting from reduced sedimentation and lowered temperatures will result in improved opportunities for cultural and subsistence fishing. Although these benefits are not quantified, the economic and cultural impact on the tribes of the Klamath Basin due to loss of salmonids fisheries is significant. The economic costs due to changes in traditional diets were explored in a recent study:

> "Whereas historic fish consumption for the Karuk Tribe is estimated at 450 pounds per person per year, fish consumption for the Tribe based on the tribal fish catch in 2003 is estimated at less than 5 pounds per person per year. . . .The central thesis of this report is that Karuk people face significant and costly health consequences as a result of denied access to many of their traditional foods. Not only does a traditional diet prevent the onset of conditions such as obesity, diabetes, heart disease, kidney trouble and hypertension, a traditional diet of salmon and other foods is one of the best treatments for such conditions" (Norgaard 2004)

The Coho Recovery Strategy also discussed this issue, but could not quantify it:

> "Coho salmon recovery will have significant costs, but will also provide economic benefits. Benefits associated with Yurok and Hoopa Valley tribes' Federally reserved fishing rights, increased commercial land and water use activities, multiple species benefits, and improved water quality and watershed health will be realized, but they are not quantified. Coho salmon recovery will also result in benefits to recreational and commercial fishing and related industries, which are also not quantified in this document" (CDFG 2004).

10.3.2 Flooding

Increased sedimentation in stream channels reduces the capacity of the channel to pass peak flows, which can result in flooding. Property damage includes fences being knocked down during floods, loss of agricultural productivity through deposition of silt on crops, threats to septic systems, loss of water supplies by filling of pools with sediment, and wear and failure of pumps and other mechanical devices. When floodwaters enter homes, they cause damage to floorings, furniture, walls, etc., and residents are forced to raise furniture and property for its protection. Cleanup after a flood event is costly and time-consuming. Residents attempt to protect their homes from floodwaters by using sandbags or by constructing walls and levees. Due to increased risk of flooding, property values are reduced and flood insurance is not only difficult to obtain, but very expensive. A decrease in the sediment loading of water bodies will decrease flooding and will result in monetized and non-monetized economic benefits.

10.3.3 Properly Functioning Ecosystems

Another large, but intangible, benefit can be ascribed to properly functioning ecosystems at various scales – local planning watershed, watershed, regional, etc. The National Academy of Sciences states, “We now think of the natural environment, and the ecosystems of which it consists, as natural capital – a form of capital asset that, along with physical, human, social, and intellectual capital, is one of society’s important assets” (National Academy of Sciences 2004). Some functions are most beneficial if they remain part of an integrated ecosystem rather than as individual components. Some of the valuable functions of intact ecosystems are nutrient recycling, regulation of climate and atmospheric gases, maintenance of biodiversity, water supply, flood risk reduction, etc. Not all of these services, of course, are impacted by excess sedimentation or high water temperature. The National Academy of Sciences has recently reviewed the studies associated with valuation of ecosystem services. They discuss several non-market valuation methods for both use and nonuse benefits. These analyses are beyond the scope of what is required for this economic analysis, but the concept of ecosystem services, apart from direct measurable goods and services, is among the intangible benefits of controlling sediment waste discharges and high water temperatures.

10.3.4 Recreation

Recreation does more than just supply leisure activity – recreation can have a significant economic impact. “Recreation and tourism are California’s largest industries. California’s rivers draw more of these users than any other location, except for its beaches” (California State Lands Commission 1993). “The demand for water-based recreation has been increasing as our population expands and the desire for outdoor recreation grows, particularly near urban areas and in national parks and other unique sites” (Koteen et al. 2002). Recreation and leisure activities provide economic value to those offering travel services,. Services and amenities proximate to the recreation locations, such as equipment rental, hotels, camp grounds, restaurants, sale of supplies, park fees, etc.

The impact of water quality on recreation varies depending on the type of recreational activity. Some activities are more sensitive to sediment and temperature related water quality impairments than others. A study by Koteen et al. (2002) showed that rafters, for example, are more interested in water quantity than sediment loads and are less willing to pay for improved water quality than are other recreational users such as swimmers, shoreline camping, fishing, and viewing. Koteen et al. (2002) summarized the value of water for particular recreational activities. They compared the mean increase in benefit to households in 1998 dollars for a specific change in water uses – such as from non-boatable to boatable; boatable to fishable; fishable to swimmable, etc. – in various geographic areas and nationwide. For example, a nationwide study showed a mean increase in benefit to households in 1998 dollars for a water quality change that allowed a change in recreation activity from boatable to fishable to be $79.60 or for a change from fishable to swimmable to be $88.68. The report also summarized a 1982 study in 119 counties in Idaho, Oregon, and Washington that calculated the mean annual recreation benefits of swimming ($54,630), camping ($49,957), fishing ($98,303), and boating ($66,515). They also summarized the marginal values of increasing water flow by type of activity, with fishing offering the highest marginal values per acre-foot for higher flows.

Recreational salmonid fishing, especially for steelhead, will increase if fish stocks recover. Recreational fishing also creates jobs. As more fish are available, recreational fishing will be more attractive. Stedman and Hanson (2005) reported: "During 1991 it was estimated that 2.7 million people spent more than $1.5 billion fishing in California. The state's recreational fishery generated more than $900 million in earnings by supporting 40,000 jobs and contributed more than $90 million in state sales tax." Some studies suggest that recreational fishing for steelhead rivals or exceeds commercial fishing for steelhead in its economic impact. Recreational fishing also supports direct and indirect economic value. "Dollars pumped into California's economy from river recreation include not only the direct value of licenses for fishing, registration of boats, equipment purchased and hiring of guides or rafts, but also the value of lodging or campsites, money generated by travel to and from the rivers, and the maintenance and repair of river-related equipment" (California State Lands Commission 1993).

The impact of reducing sediment loads and improving water temperatures on recreational uses (and the associated economic benefit) will vary, depending on the activity and location. Recreational fishing appears to be highly sensitive to water quality improvements – not only because of the nature of the recreational water contact (i.e., it is more desirable to fish in clear water), but also because of the impact of poor water quality on fish stocks.

10.3.5 Remediation - Habitat Restoration and Road Maintenance

Remediation costs can be expected to decrease if sediment discharges and adverse impacts to temperature are prevented. Remediation of fish habitat after impairment occurs can be expensive. The need for expensive restoration and remediation will be reduced, if not eliminated, if waste sediment can be prevented from discharging to water bodies and adverse impacts to temperature can be lessened.

The failure to prevent discharges can result in much larger costs for landowners for remediation and restitution after degradation occurs. Prevention is far less expensive than remediation after degradation occurs. Recent enforcement cases in the North Coast Region illustrate how expensive remediation and enforcement costs can be. In one recent case, a vineyard expansion with substantial grading and road development resulted in serious erosion to three nearby water bodies. The landowner was required to install erosion control measures, repair erosion damage, re-vegetate, grade, drain, remove fill, restore channels, and hire consultants including biologists, engineers, and geologists. The restitution costs were $225,000 and the remedial work to restore the property was about $750,000. Additionally, there were legal fees associated with the criminal charges that were filed. In another case, roadwork for a home site development resulted in a large sediment discharge to a creek. The restitution and remediation was about $1.5 million (with $277,500 for cleanup and land stabilization).

Typical costs associated with stream-bank remediation and restoration can be avoided if the adverse impacts can be prevented or minimized. Some of the typical costs are provided by the 2004 Coho Recovery Strategy and are excerpted in Table 10.1. Actual costs will vary depending on many site-specific factors, such as site accessibility, on the specific work that is required, and the prevailing prices and wage rate in the area. The need for these activities and the associated costs will be reduced, if not eliminated, if compliance with existing water quality requirements prevents the discharge of excess waste sediment to waters of the state and reduces water temperatures.

Road maintenance costs for both the private and public sectors can be expected to decrease if roads are properly designed for sediment control. Some costs associated with this activity may be transferred to an earlier time, leading to a short-term increase but an overall decrease in costs. For example, replacing an inadequate stream crossing before it fails and releases sediment to a water body would be a short-term cost increase, but would save the larger cost of fixing a failed crossing. Similarly, storm-proofing roads so that they can shed water without causing gullies will lead to a short-term cost increase, but the annual maintenance costs will be lower than if gullies, etc. have to be repaired on an on-going basis. The 2004 Coho Recovery Strategy (CDFG 2004) talks about the need to control sediment associated with roads – using techniques such as, removing unstable sidecast and fill materials from steep slopes, improving surface drainage, and upgrading stream crossings. These cost are excerpted in Table 10.1.

Table 10.1
Costs of Typical Habitat Restoration Activities
(Adapted from Appendix I of CDFG 2004 Coho Recovery Strategy)

Activity	Units	Cost ($)
Compacted fill	CY	2.50
Cut and fill	CY	130.00
Geotextile fabric	SF	1.25
Grading and shaping	AC	200.00
Mobilization	Each	1,250.00
Rock, in place	CY	100.00
Rock/fill	CY	50.00
Seedbed preparation	AC	50.00
Stream tree revetment	Each	22.00
Wildlife repellent (chemical)	LF	125.00
Stream bank protection, general	LF	125.00
General control fencing	LF	3-12.00
Labor requirements for stream-bank improvements in California		
Brush layering	LF/hr	6-7.00
Fascine placement	LF/hr	5.00
Seedling planting	plants/hr	30-120.00
Seeding	AC/hr	0.05-0.50
Hydroseeding	AC/hr	0.12-0.37

"USDA cost estimates report that stream-bank protection projects in general cost about $125 per square foot in California. However, these cost estimates do not include the cost of maintenance or permitting." The coho strategy provides estimates of permitting and short-term maintenance to be $30 to $1000 per foot.
AC = acre CY = cubic yard LF = linear foot SF = square foot

10.3.6 Residential Land Prices

Water quality has a positive economic impact on property values, even if property owners do not consume the water. Koteen et al. (2002) summarized studies concerning the change in residential property prices near waterbodies as related to changes in water clarity. "The studies examined the change in property price for each foot of lake frontage given a 1-foot improvement in water clarity." The studies found price increases ranging from $2.34 per foot of lakefront in Minnesota to $16-28 in Maine. Conversely, the authors include a study showing a decrease in property value related to a decrease in water clarity in Florida. The precise property value changes discussed in the report cannot, of course, be applied directly or quantitatively to the Scott River watershed; the authors caution, "The value is unique for each situation, such as location and current clarity." The tendency, though, for property values to increase when water quality is increased is borne out by other studies.

10.3.7 Water Conveyance and Storage Facilities

Excess water-borne sediment is deposited in slow moving areas, such as reservoirs and irrigation canals. This will reduce the life of these facilities. Higher sediment loads increase maintenance costs of irrigation canals and reservoirs. The capacity of reservoirs is reduced. The costs avoided by reducing sediment loads are difficult to quantify, but dams are expensive and this economic benefit is likely large overall.

10.4 COSTS

Compliance with existing water quality regulatory requirements will have positive and negative economic impacts. This section presents these estimated costs. These costs relate to the economic impacts of compliance and remediation. See Section 10.2 for a discussion of the costs that can be ascribed to the Scott River Action Plan compared to the costs that are imposed by existing regulatory requirements.

The costs of complying with existing water quality regulatory requirements will not be uniformly distributed throughout the Scott River watershed. The types of actions anticipated (see Chapter 5 of this Staff Report) are not uniformly required across the Scott River watershed or even across properties with similar land uses. Instead, the extent of the implementation action necessary is not known and may change based on the success of implementation. Additionally, there are various ways to address a given impairment and not all the management measures listed may be needed. Also, some of the actions called for in the Scott River TMDL Action Plan (such as control fencing and road inventories) are already in place or completed. Finally, many of the implementation actions will be required of landowners on an as-needed, site-specific basis or are simply activities that are encouraged by the Regional Water Board. While this flexibility should greatly improve the effectiveness of the complying with existing water quality regulatory requirements, it is a factor that prevents this economic analysis from totaling benefits and cost on a watershed scale. Therefore, estimated costs are expressed on a unit scale (e.g., per acre, per linear foot of fence).

10.4.1 Methodology

The cost analysis was conducted to provide approximate estimates of the cost of complying with existing water quality regulatory requirements. An economist on staff with the State Water Resources Control Board assisted in developing this analysis (see Horner 2005 for more information). Costs of management measures that are likely to be required to achieve the types of actions specified in the TMDL were estimated using the Natural Resource Conservation Service (NRCS) Program Costs derived from the ProTracts cost dataset. ProTracts is a national dataset maintained by NRCS to assist local NRCS Districts in setting cost shares for implementing conservation practices. Cost estimates are provided at the county level and the data used for this analysis are specific to Siskiyou County. These cost estimates may not represent the total cost of implementing a management practice, but they do provide a reasonable approximation of costs that can be adjusted if necessary. NRCS Program Costs are updated on a monthly basis.

Management measures that are likely to achieve proposed implementation actions are varied and numerous. An early step in this analysis was to select the management measures from the NRCS Program Costs database that are the most appropriate and the most likely to be used to reduce sediment waste discharges and elevated water temperatures. Table 10.2 lists the NRCS Program Costs management measure categories. The management measures that were selected are highlighted in bold text.

Table 10.2
NRCS Program Costs Management Measures

Code	Name		Code	Name
322	Channel Vegetation		548	Grazing Land Mechanical Treatment
327	Conservation Cover		550	Range Planting
328	Conservation Crop Rotation		**554**	**Drainage Water Management**
329	Residue Management, No-Till/Strip Till		555	Rock Barrier
330	Contour Farming		**560**	**Access Roads**
332	Contour Buffer Strips		561	Heavy Use Area Protection
340	Cover Crop		562	Recreation Area Improvement
342	Critical Area Planting		566	Recreation Land Grading and Shaping
344	Residue Management, Seasonal		568	Recreation Trail and Walkway
350	Sediment Basin		**570**	**Runoff Management System**
382	**Fence**		572	Spoil Spreading
386	**Field Border**		**574**	**Spring Development**
390	Riparian Herbaceous Cover		575	Animal Trails and Walkways
391	**Riparian Forest Buffer**		**580**	**Streambank and Shoreline Protection**
393	**Filter Strip**		582	Open Channel
410	Grade Stabilization Structure		584	Channel Stabilization
412	Grassed Waterway		585	Stripcropping
422	Hedgerow Planting		600	Terrace
423	Hillside Ditch		601	Vegetative Barriers
450	Anionic Polyacrylamide Erosion Control		**607**	**Surface Drainage, Field Ditch**
468	**Lined Waterway or Outlet**		**612**	**Tree/Shrub Establishment**
484	Mulching		**614**	**Watering Facility**
490	Forest Site Preparation		638	Water and Sediment Control Basin
511	Forage Harvest Management		655	Forest Trails and Landings
512	Pasture and Hay Planting		666	Forest Stand Improvement

10.4.2 Estimated Costs for Scott River TMDL Action Plan

Because the Scott River TMDL Action Plan does not include any additional regulatory requirements, the estimated costs of the Scott River TMDL Action Plan are theoretically zero, since should the Plan be adopted and implemented as proposed, the only costs are those associated with compliance with existing water quality regulatory requirements. These costs , and are listed in Table 10.3. The table is organized in the same order as the proposed implementation actions in Chapter 5. This information is based on the economic analysis conducted by an economist on staff with the State Water Resources Control Board (Horner 2005).

As discussed above, a single management measure will likely not be implemented over the entire extent of a given land use or across the entire Scott River watershed. It is up to the landowner/discharger to decide which implementation actions and management measures are most appropriate to control sediment and water temperature on his or her property. Also, some of the management measures have already been implemented or are required by other regulatory programs.

Table 10.3 Estimated Costs for Compliance with Existing Sediment and Temperature Water Quality Regulations		
Estimated Costs for Roads & Sediment Waste Discharges		
Development of an Erosion Control Plan	Timberland: $23.70 to $77.40 per acre Non-Timberland: $35.28 to $77.40 per acre	Based on estimates on the cost of developing an Erosion Control Plan from Pacific Watershed Associates (Weaver & Hagans, 2004; Fitzgerald, 2005a)
Grading and Shaping of Roads, Trails, and Landings	$200 per acre	Per NRCS Program Costs database. Assumes roads, trails, and landings are gravel and dirt.
Estimated Costs for Dredge Mining Implementation Actions		
Investigation & Study of Impacts	$60,000 total over three years.	Based on the cost for a state employee to conduct the proposed study. Assuming 0.20 personnel years at an annual cost of $100,000 per personnel year for three years.
Estimated Costs for Temperature and Vegetation Implementation Actions		
Planting Trees	$180 per acre.	Per NRCS Program Cost database.
Maintaining Trees	$800 per acre.	Per NRCS Program Cost database.
Fencing	$3.25 per running foot of fence	Per NRCS Program Cost database.
Installation of Remote Water Supply (Tanks)	$1.75 per gallon of tank capacity	Per NRCS Program Cost database.
Table 10.3 (cont.) Estimated Costs for the Scott River TMDL Action Plan		
Estimated Costs for Water Use Implementation Actions		
Develop a Study Plan	$120,000 total over three years.	Based on the cost for staff of the State and the County of Siskiyou to develop the Study Plan. For the state, this estimate assumes 0.20 personnel years at an annual cost of $100,000 per personnel year for three years ($60K). For the county, it assumes 0.20 personnel years at an annual cost of $100,000 per personnel year for three years ($60K).
Estimated Costs for Flood Control and Bank Stabilization Implementation Actions		
Planting Trees	$180 per acre.	Per NRCS Program Cost database.

Maintaining Trees	$800 per acre.	Per NRCS Program Cost database.
Estimated Costs for Implementation Actions for the USFS & BLM		
Development of an Erosion Control Plan	$23.70 to $77.40 per acre	Based on estimates on the cost of developing an Erosion Control Plan from Pacific Watershed Associates (Weaver & Hagans, 2004; Fitzgerald, 2005a)
Grading and Shaping of Roads, Trails, and Landings	$200 per acre	Per NRCS Program Costs database. Assumes roads, trails, and landings are gravel and dirt.
Analyze Current Grazing Management Practices and Monitoring Activities	$70,000 total over one year	Based on the cost for staff of the State, the USFS, and BLM to conduct the analysis. For the state, this estimate assumes 0.10 personnel years at an annual cost of $100,000 per personnel year for one year ($10K). For the USFS and BLM, it assumes 0.30 personnel years each at an annual cost of $100,000 per personnel year for one year ($30K x 2 = $60K).
Estimated Costs for Grazing Implementation Actions		
Fencing	$3.25 per running foot of fence	Per NRCS Program Cost database.
Installation of Remote Water Supply (Tanks)	$1.75 per gallon of tank capacity	Per NRCS Program Cost database.
Development of a Grazing and Riparian Management Plan	Level Ground: $8.50 to $12.50 per acre Steep Ground: $12.50 to $18.50 per acre	Based on the estimated cost for a consultant to prepare the plan at a rate of $200 to $300 per day. A plan for 100 acres of flat ground would take about 4 days to prepare and a plan for 100 acres of steep ground would take about 6 days to prepare. Miscellaneous expenses (e.g., gas) are also included (Fitzgerald, 2005b).

10.5 SOURCES OF FUNDING

Potential sources of funding include monies from private and public sources. Public financing includes, but is not limited to, grant funds, as described below, single-purpose appropriations from federal, state, and/or local legislative bodies, and bond indebtedness and loans from government institutions.

There are several potential sources of public financing through grant and funding programs administered, at least in part, by the Regional Water Board and the State Water Board. These programs vary over time depending upon federal and state budgets and ballot propositions approved by voters. Regional and State Water Board grant and funding programs that are pertinent to the proposed Action Plan for the Scott River Sediment and Temperature TMDLs and are currently available at the time of this writing or will be available in the near future are summarized and described below.

Consolidated Watershed Nonpoint Source Grant Program (Proposition 40)

The Consolidated Watershed Nonpoint Source (NPS) grant program is funded by Proposition 40, the California Clean Water, Clean Air, Safe Neighborhood Parks, and Coastal Protection Act of 2002. This program has not yet solicited grant proposals, but will fund nonpoint source, coast non-point source, urban storm water, and watershed management projects.

Nonpoint Source Pollution Control Program (Proposition 40)

The Non-point Source Pollution Control Program provides funding for projects that protect the beneficial uses of water throughout the state through the control of nonpoint source pollution. Up to $19 million is available to local public agencies and non-profit organizations.

Integrated Regional Watershed Management Grant Program (Proposition 40)

The Integrated Regional Watershed Management grant program funds projects for development of local watershed management plans and for implementation of watershed protection and water management projects. This grant program will provide $47.5 million statewide for competitive grants to non-profit organizations and public agencies.

Integrated Regional Water Management (IRWM) Grant Program (Proposition 50)

The IRWM Grant Program is a joint program between the Department of Water Resources (DWR) and the State Water Board which provides funding for projects to protect communities from drought, protect and improve water quality, and reduce dependence on imported water. Funding is available for both IRWM Planning and Implementation Grants.

CHAPTER 11. PUBLIC PARTICIPATION

Key Points

- The public has had many opportunities to comment on and participate in the development of this Draft Scott River TMDL Action Plan and Staff Report.
- The Scott River TMDL Technical Advisory Group (TAG) has provided input and advice to Regional Water Board staff. Staff have responded to many questions and comments raised by the TAG.
- A public Scoping Meeting was held to solicit public comment on the scope of the environmental review.
- Status updates and presentations on the Scott River TMDL have been made to the Regional Water Board and members of the public.
- There will be many more opportunities for public input and comment on the Scott River TMDL Action Plan.

This chapter describes some of the opportunities that have been made available to the public for comment on and participation in the development of the Scott River TMDL Action Plan.

11.1 SCOTT RIVER TMDL TECHNICAL ADVISORY GROUP

The Scott River Sediment and Temperature TMDL Technical Advisory Group (TAG) was formed to provide input and advice to staff of the Regional Water Board during development of the technical TMDLs for sediment and temperature in the Scott River watershed. Although forming a TAG was not a requirement of the Basin Plan amendment process, the existence of the TAG engaged members of the community and helped to produce a more robust TMDL Action Plan.

Members of the TAG included representatives from the California Department of Fish & Game, the California Department of Forestry & Fire Protection, the California Department of Water Resources, the County of Siskiyou, the Farm Bureau, Fruit Growers Supply Company, the National Oceanic & Atmospheric Administration, the Natural Resources Conservation Service, the Quartz Valley Indian Community, the Scott River Watershed Council, the Siskiyou Resource Conservation District, Timber Products Company, the United States Fish & Wildlife Service, the University of California Cooperative Extension, the Karuk Tribe, several members of the local communities, and contractors working on behalf of the Regional Water Board to assist with the development of certain sections of the TMDL.

Six meetings were held over the course of the TMDL development period, which began in earnest in January 2003. During this time, Regional Water Board staff presented the following documents for TAG review and comment:

- Scott River Temperature TMDL Monitoring and Study Plan (May 2003).
- Scott River Sediment TMDL Monitoring and Study Plan (December 2003).
- Scott River Mainstem Temperature Analysis Update: 2003 Monitoring Results, Working Hypotheses, and Next Steps (April 2004).
- Scott River Basin Sediment TMDL Stratified Random Sampling for Streamside and Road-Associated Sediment Contribution (May 2004).
- Scott River Sediment TMDL Source Analysis Strategy (August 2004).
- Scott Temperature TMDL Source Analysis Methods (December 2004).
- South Fork Scott River Pilot Study for the Sediment TMDL (January 2005).

Throughout the TAG process, Regional Water Board staff attempted to respond to questions and concerns raised by the TAG. Several examples of staff responses to TAG suggestions are as follows:

Temperature:

- In response to concerns that a single simulation period (August 27 –September 10, 2003) was not an adequate basis for analysis, the July 28 – August 1 Scott River model application was developed and model scenarios completed. The task resulted in a doubling of the total number of Scott River model runs conducted.
- A vegetation ecologist was contracted to develop a riparian vegetation analysis. Two field trips were held in order to discuss approaches, RipTopo model assumptions, and to evaluate tree heights predicted by the RipTopo model.
- A new approach was developed to depict potential vegetation conditions in areas where whole scale vegetation changes have occurred. The new approach eliminated the use of the “nibble function” applied in the first draft of the RipTopo results, and instead used a set of decision rules developed with TAG member input to simulate potential vegetation conditions.
- Riparian vegetation conditions shown in the 1944 aerial photos were reviewed and compared to RipTopo modeling results.
- Numerous wording changes were made to early draft products in response to TAG comments.
- Many comments and suggestions received from TAG members on an early draft of the Scott River TMDL Action Plan and Staff Report were incorporated.

Sediment:

- In response to an overarching concern about the field and analytical methods proposed for use in the Scott River temperature TMDL analysis, Regional Water Board staff agreed to prepare a pilot study for the South Fork Scott subwatershed, and designed, implemented, and prepared a report on the results of the Pilot Study.
- TAG input on the Pilot Study indicated a need to consider granitic areas separately from areas underlain by other geologies. This approach was developed and forms the basis for the proposed TMDL.

- Best efforts were made to separately describe and account for distinct land uses, such as forestry and mining.
- Significant additional explanation of methods and procedures was developed for the streamside features analysis.
- Many comments and suggestions received from TAG members on an early draft of the Scott River TMDL Action Plan and Staff Report were incorporated.

11.2 SCOPING MEETING

The purpose of the Scoping Meeting was to solicit public comments to help staff assess the potential environmental scope of the environmental analysis. Holding a scoping meeting is a requirement of the California Environmental Quality Act (CEQA). The Scoping Meeting was held on June 28, 2005, in Yreka, California. Many of the comments received at the CEQA Scoping meeting concerned technical aspects of the initial proposal rather than the scope of the environmental review. The comments received at the CEQA Scoping Meeting that concerned the scope of the environmental review are summarized in Chapter 9. These comments, and others, helped to shape the scope of the environmental review and specific aspects of the resulting proposal.

11.3 PRESENTATIONS TO THE REGIONAL WATER BOARD

Periodically, Regional Water Board staff presented updates and status reports to the Regional Water Board and interested members of the public on the Scott River TMDL and related efforts in the Klamath River Basin. Presentations were made on February 10, 2004 in Santa Rosa, on May 4, 2005 in Weaverville, and on August 10, 2005 in Santa Rosa. The presentations were opportunities for the public and Board members to hear status updates and background information. At each of these meeting, the public also had the opportunity to give comment before the Board. All such comments are part of the public record.

11.4 OTHER ACTIVITIES

On October 1, 2002, Regional Water Board staff presented the TMDL program and schedule for TMDL development to the Siskiyou County Board of Supervisors. Regional Board staff made a presentation to the Siskiyou County Board of Supervisors on October 12, 2005. Regional Water Board staff have maintained regular contact with County staff regarding the status of TMDL development throughout the process.

On October 3, 2002, Regional Water Board staff presented the TMDL program and schedule for the Scott River TMDLs to the Siskiyou Resource Conservation District Board in Etna.

On January 9, 2003, Regional Water Board staff made a presentation to the Statewide Coho Recovery Team convened by the California Department of Fish and Game. Regional Water Board staff also attended, as members of the public, a series of meetings of the Scott-Shasta

Recovery Team, a separate effort associated with the statewide Coho Recovery Team aimed specifically at developing elements of recovery plans for these watersheds. This coordination identified areas of overlap between the TMDL and Coho Recovery efforts, aligned Coho Recovery recommendations to minimize conflict with TMDL goals, and provided an opportunity for ongoing discussion with individuals and organizations also involved in the TMDL process.

Regional Water Board staff have given regular updates on the status of TMDL activities in the Klamath Basin to the Klamath Basin Fisheries Task Force and its subgroups. Presentations were made to the full Task Force on June 24, 2004, June 15, 2005, and October 19, 2005, and to the Task Force's Technical Working Group on December 7, 2004.

The USEPA and the Regional Water Board have initiated an informal consultation process with the U.S. Fish and Wildlife Service (USFWS) and the National Oceanic and Atmospheric Administration, Fisheries (NOAA Fisheries) on Klamath River TMDLs. Regional Water Board and USEPA staff have used this process to provide information and updates on the TMDLs in the Klamath River Basin, namely the Salmon, Scott, Shasta, Lower Lost, and Klamath River TMDLs. In addition, both NOAA Fisheries and the USFWS have attended the Scott River TMDL Technical Advisory Group meetings.

The USEPA has held regular meetings with representatives of tribes in the Klamath River Basin watershed in California and the Regional Water Board to provide updates on the TMDL process, as part of USEPA's tribal trust responsibilities. These meetings have been held approximately quarterly for the last several years.

In addition, there has been and continues to be informal contact with many individuals and organizations active in the Scott River watershed.

11.5 PUBLIC DRAFT

The Scott TMDL and Action Plan were released for public comment on September 20, 2005.

Public Comment Period .... September 20 to November 3, 2005

Public Informational Workshop ....October 12, 2005
before the Regional Water Board in Santa Rosa, CA

Public Informational Workshop (Yreka) ....October 18, 2005

Public Informational Workshop (Arcata) October 19, 2005

11.6 FUTURE PUBLIC PARTICIPATION OPPORTUNITIES

Throughout the Basin Plan amendment process, there are opportunities for public participation and comment, including at the CEQA scoping meeting, at the Regional Board and associated workshops prior to the Regional Board hearing for the proposed TMDL Basin Plan amendment, at the Regional Board hearing to consider adoption of the TMDL Basin Plan amendment, before the State Board, and during public forum at any Regional Board meeting. The following opportunities and their estimated dates remain for public comment on the proposed Scott River TMDL Basin Plan amendment. Please note that the following dates may change.

Public Workshop and Hearing .... April 2006
before the State Water Resources Control Board in Sacramento, CA

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GLOSSARY

Active Channel	The area of the stream channel that is seasonally inundated, and often scoured free of perennial vegetation.
Adjusted Potential Effective Shade	The percentage of direct beam solar radiation attenuated and scattered before reaching the stream surface by the potential vegetation conditions, reduced by 10% to account for natural disturbances such as fire, windthrow, disease, and earth movements that reduce the actual riparian vegetation below the site potential.
Aggradation	Rise of the stream bed level resulting from deposition of sediment.
Anadromous	Refers to aquatic species that migrate up rivers from the sea to breed in fresh water, undergoing a physiological change to allow them to adjust from freshwater to saltwater to freshwater conditions.
Bankfull	The discharge at which channel maintenance is most effective over time, generally with a frequency interval of once every 1.5-2.3 years. Also, the channel form that accommodates the bankfull flow.
Bankfull Channel	The stream channel that contains the bankfull flow.
Basin Plan	Water Quality Control Plan for the North Coast Region (Region 1).
Beneficial Use	Use of waters of the state designated in the Basin Plan as being beneficial. Beneficial uses that may be protected against quality degradation include, but are not limited to: domestic, municipal, agricultural, and industrial water supply; power generation; recreation; aesthetic enjoyment; navigation; and the preservation and enhancement of fish, wildlife and other aquatic resources or preserves.
Cable Yarding	Yarding of cut timber accomplished by dragging or suspending cut timber up a hillslope from the cut area to a ridgetop landing.
CDF	California Department of Forestry and Fire Protection.
CDFG	California Department of Fish and Game.
CDWR	California Department of Water Resources.
cfs	Cubic feet per second: a measure of water flow.

Compliance and Trend Monitoring	Monitoring intended to determine, on a watershed scale, if water quality standards are being met, and to track progress towards meeting water quality standards.
Decommission	To close and obliterate a road, restore the land to more resemble its natural contours, and return drainage patterns to their natural state.
Degradation	Lowering of the channel bed resulting from scour during flood flows. Also, lowering or degrading of quality.
Diversion Potential	The potential for a road to divert water from its intended drainage.
DG	Decomposed granite.
Drainage Structure	A structure or facility constructed to control road runoff, including (but not limited to) a ford, inside ditch, water bar, outslope of the road, rolling dip, culvert, or ditch drain.
Effective Shade	The percentage of direct beam solar radiation attenuated and scattered before reaching the ground or stream surface from topographic and vegetation conditions.
Electroshocking	A sampling technique for fish surveys that uses electrical current to stun fish in the water, allowing them to be measured and released.
Embeddedness	The degree to which larger streambed sediment particles (boulders, rubble, or gravel) are surrounded or covered by fine sediment. Embeddedness is usually estimated visually in classes (<25%, 25-50%, 50-75%, and >75%) according to the percentage of random large particles that is covered by finer sediment.
Encouragement	Encouragement may take several forms, including efforts by Regional Water Board staff to work with stakeholders to facilitate the planning and implementation of restoration and enhancement projects, staff providing technical assistance for landowners and stakeholders when such assistance is requested, efforts by staff to make compliance with the Nonpoint Source Policy compatible with restoration and enhancement projects, staff coordinating efforts within the Regional Water Board office to simplify and speed up the permit approval process, and formal recognition by the Regional Water Board of good works that improve water quality.
EPA	United States Environmental Protection Agency.
Erosion	The group of processes whereby sediment (rock and soil material) is loosened, dissolved, or removed from the landscape surface. It includes weathering, dissolution, and transportation.

ESU	Evolutionarily Significant Unit, used by NMFS to identify a distinctive group of Pacific salmon or steelhead for purposes of the federal Endangered Species Act.
Flooding	Overflowing of water onto land that is dry most of the time.
FPR	Forest Practice Rules, defined by the Z'berg-Nejedly Forest Practice Act of 1973, as amended.
FWS	United States Fish and Wildlife Service
Fry	A young juvenile salmon after it has absorbed its egg sac and emerged from the redd. Word is singular or plural.
GIS	Geographic Information System.
Groundwater Accretion	The gradual increase in surface flow in a stream resulting from the influx of groundwater.
GSS	Granitic Sediment Study of Sommarstrom and others (1990)
Headwall Swale	Topographic depression in the headwaters area of a watercourse or head of a landslide area; often a potentially unstable area where moisture tends to collect.
Hydrologically Closed Road	Generally refers to a road that is closed to further use and has natural flow conditions restored (e.g., stream crossing fill removed), although the road itself may not be revegetated or obliterated.
Hydrologically Connected Road	Road with drainage that is collected and directed toward a watercourse.
Hydrologically	A road constructed so that drainage of the road is self-maintaining..
ICE	Information Center for the Environment at UC Davis.
Implementation Monitoring	Monitoring used to assess whether activities and control practices were carried out as planned. This type of monitoring can be as simple as photographic documentation, provided that the photographs are adequate to represent and substantiate the implementation of control practices.
Inner gorge	A geomorphic feature; generally a steep-walled inner part of a valley immediately adjacent to the stream, having a slope generally over 65%, and lying below less steep upper valley sides.

Inside ditch	Ditch on the side of the road toward the hill slope, usually at the foot of the cutbank.
Instream Effectiveness Monitoring	Monitoring of instream conditions to assess whether sediment control practices are effective at keeping waste sediment from being discharged to a water body. Instream effectiveness monitoring may be conducted upstream and downstream of the discharge point or before, during, and after the implementation of sediment control practices.
Key Piece of LWD	As a narrative, a key piece of LWD is a log or root wad that (1) is independently stable in the stream bankfull width and not functionally held by another factor (e.g., not pinned by another log, buried, or trapped against a rock, etc) and (2) is retaining, or has the potential to retain, other pieces of organic debris that are likely to become mobilized in a high flow without the key piece. Numerically, key pieces are logs with a minimum diameter of twelve inches and minimum length 1.5 times the mean bankfull width of the stream channel type reach and the deployment site. Root wad key pieces have a minimum root bole diameter of five feet and minimum length of fifteen feet and minimum width at least half the channel type bankfull width. Key pieces of LWD are also those pieces that meet the following criteria found in Table G.1.
Landslide	Any mass movement process characterized by downslope transport of soil and rock under gravitational stress, generally by sliding over a discrete failure surface or combination of surfaces -- or the resultant landform.
Large Woody Debris	Woody material generally having a diameter greater than 30 cm (12 inches) and a length greater than 2 m (6 feet) located in watercourse or in a position where it may enter a watercourse.
Low-Flow Channel	The part of a stream that is occupied by water during the periods of lowest flow, generally in late summer or early fall.
Mass Wasting	Downslope movement of soil mass under force of gravity, often used synonymously with "landslide." Common types if mass movement include rockfall, soil creep, slump, earthflow, debris avalanche, and debris slide.
Natural Receiving Water Temperatures	The water temperatures that result when the environmental factors that influence stream temperature have not be altered by human activities.
NCRWQCB	North Coast Regional Water Quality Control Board. Also known as: Regional Board; Regional Water Board; and California Regional Water Quality Control Board, North Coast Region.

Table G.1
LWD Key Piece Volume Criteria
(taken from Schuett-Hames et al., 1999b; modified with results from Fox, 2001)

Min. Diameter in meters	Minimum Length of LWD in meters			
	BFW > 0 to < 5	BFW 5 to < 10	BFW 10 to < 15	BFW 15 to < 20
0.20	32			
0.25	21			
0.30	15	36		
0.35	11	26		
0.40	8	20		
0.45	7	16	38	
0.50	6	13	31	
0.55	5	11	26	
0.60	4	9	22	32
0.65	3	8	19	28
0.70	3	7	19	24
0.75	3	6	14	21
0.80	2	5	12	18
0.85	2	5	11	16
0.90	2	4	10	15
0.95	2	4	9	13
1.00	2	4	8	12
1.05	2	3	7	11
1.10	2	3	7	10
1.15	1	3	6	9
1.20		3	6	8
1.25		3	5	8
1.30		2	5	7
1.40		2	4	6
1.55		2	4	5
1.60		2	3	5
1.70		2	3	4
1.80		1	3	4
2.00			2	3
2.40			2	2
2.80			1	2
3.40				1

Meter/Feet conversion: meters x 3.281 = feet

Minimum LWD Volume to Qualify as a Key Piece

BFW (m)	Volume (m^3)
0 to < 5	1
5 to < 10	2.5
10 to < 15	6
15 to < 20	9
20 to < 30	9.75
30 to < 50	10.5*
50 to 100	10.75*

* Wood piece must have an attached root wad.

Procedure:
1. Select segment bankfull width (BFW) category.
2. Measure diameter of candidate pieces and round to nearest 0.05 m (5 cm)
3. Follow matrix across to find the minimum length requirement.

Key Log Example:
1. Segment has an average BFW of 12 m (use BFW column of 10 to < 15 m).
2. Candidate log diameter is measured/ estimated to be 0.53 m (round to 0.55 m).
3. Log must be a minimum of 26 m long (measure/estimate log length to assess if it is a key piece).

Key Rootwad Example:
1. Segment has an average BFW of 4 m (use BFW column of 0 to < 5 m).
2. A rootwad Key Piece must have a minimum diameter of 1.15 m and length of 1 m.

NMFS	National Marine Fisheries Service.
NTU	Nephelometric Turbidity Units, a standard measure of turbidity.
Periodicity	The presence of salmonids at varying life stages throughout the year.
Pool Tail-out	The downstream end of a pool, where the main current narrows, forming a "tail." aka riffle head.
Potential Vegetation Conditions	The most advanced seral stage that nature is capable of developing and making actual at a site in the absence of human interference. Seral stages are the series of plant communities that develop during ecological succession from bare ground to the climax community (e.g., fully mature, old-growth).
Primary Pool	A pool that is at least as long as the low-flow channel width, and occupies at least half the width of the low-flow channel and, for 1st and 2nd order streams, is at least 2 ft or more in depth; and for 3rd order and higher streams, is at least 3 ft or more in depth. (Flosi et al. 1998).
PW	Planning Watershed.
Reach	Limited stretch of a stream considered for a specific purpose.
Redd	A gravel nest or depression in the stream substrate, created by a female salmonid, in which eggs are laid, fertilized, and covered with gravel for a period of incubation.
Refugia	Habitat areas that allow refuge from poor habitat conditions.
Regional Water Board	California Regional Water Quality Control Board, North Coast Region.
Riffle	A reach of stream characterized by an increased water velocity resulting from a drop in elevation, usually shallow..
Riffle Head	The beginning (i.e., upstream end) of a riffle (aka pool tail-out).
Road	Any vehicle pathway, including, but not limited to: paved roads, dirt roads, gravel roads, public roads and highways, private roads, rural residential roads and driveways, permanent roads, temporary roads, seasonal roads, inactive roads, trunk roads, spur roads, ranch roads, timber roads, skid trails, and landings which are located on or adjacent to a road.
Salmonids	Fish species in the family Salmonidae, including but not limited to, salmon, trout, and char.

Sediment	Any inorganic or organic earthen material, including, but not limited to: soil, silt, clay, and rock. Fragmental material that originates from weathering of rocks and decomposed organic material that is transported by water, as bedload, suspended load, or dissolved load, and eventually deposited.
Sediment Delivery	Sediment delivered to a watercourse.
Sediment Source	The physical location on the landscape where earth material has or may have the ability to discharge into a watercourse.
Sediment Yield	The quantity of sediment, expressed by weight or volume, produced from a unit area in a unit time.
Sediment Waste	Sediment that is generated directly or directly by anthropogenic activities or projects.
Sediment Waste Discharge Site	An individual, anthropogenic erosion site that is currently discharging or has the potential to discharge sediment waste to waters of the State.
Sidecast	Fill from road construction or grading that is deposited to a hillside below a road.
Skid Trail	Constructed trail or established path used by tractors or other vehicles for skidding logs. Also known as tractor road.
Smolt	A young salmon at the stage intermediate between the parr and the grilse, when it becomes covered with silvery scales and first migrates from fresh water to the sea.
Smoltification	Suite of physiological, morphological, biochemical and behavioral changes, including development of the silvery color of adults and a tolerance for seawater, that take place in salmonid parr as they migrate downstream and enter the sea
Stream	See watercourse.
Stream order	The designation (1,2,3, etc.) of the relative position of stream segments in the drainage basin network. For example, a first order stream is the smallest, unbranched, perennial tributary which terminates at the upper point. A second order stream is formed when two first order streams join. A third order stream is designated where two 2nd- order streams join.
SW	Sub-watershed

Tail-out	Lower end of a pool where flow from the pool, in low flow conditions, discharges into the next habitat unit, usually a riffle. Location where spawning generally occurs.
Thalweg	The deepest part of a stream channel at any given cross section.
Thalweg profile	Elevation profile surveyed along the length of the stream and centered on the water surface over the deepest part of the stream.
Thermal Refugia	Colder areas within a water body that provide cold water refuge from unsuitably warm water.
THP	Timber Harvest Plan
Timber Harvest Activities	Commercial and non-commercial activities relating to forest management and timberland conversions. These activities include the cutting or removal of both timber and other solid wood forest products, including Christmas trees. These activities include, but not limited to, construction, reconstruction and maintenance of roads, fuel breaks, firebreaks, watercourse crossings, landings, skid trails, or beds for the falling of trees; fire hazard abatement and fuel reduction activities; burned area rehabilitation; and site preparation that involves disturbance of soil or burning of vegetation following timber harvesting activities; but excluding preparatory tree marking, surveying, or road flagging.
TMDL	Total Maximum Daily Load, as defined under section 303(d) of the Clean Water Act, and regulations at 40 CFR §130.
Tractor Yarding	Yarding of cut timber using a tractor.
Turbidity	A measure of the degree to which water obstructs the passage of light. High turbidity (low light transmissivity) can be caused by suspended fine sediments or organic material.
Unstable area	Location on the landscape that has a higher than average potential to erode or otherwise fail and discharge sediment to a watercourse. Includes slide areas, gullies, eroding stream banks, and unstable soils. Slide areas include landslides of all sizes and depths, debris flows, debris slides, earthflows, inner gorges, and hummocky ground. Unstable soils include unconsolidated, non-cohesive soils and colluvial debris.
Upslope Effectiveness Monitoring	Monitoring intended to determine, by assessing upslope conditions, if sediment control practices are effective at keeping waste sediment from being discharged to a water body. This type of monitoring can be as simple as photographic documentation, provided that the photographs are adequate to represent and substantiate that the sediment control practices are effective.

V*	A numerical value that represents the proportion of fine sediment that occupies the scoured residual volume of a pool, as described by Lisle and Hilton (1992). Pronounced "Vee-star."
Watercourse	Any well-defined channel having a distinguishable bed and bank and showing evidence of having contained flowing water as indicated by deposit of rock, sand, gravel, or soil.
Waters of the State	All ground and surface waters, including saline waters, within the boundaries of the state.
Watershed	Total land area draining to any point in a watercourse, as measured on a map, aerial photo or other horizontal plane. Also called a basin, drainage area, or catchment area.
Water Quality Criteria	Numeric or narrative criteria established under the Clean Water Act to protect the designated uses of a water body.
Water Quality Indicator	Factor or condition that determines or expresses the quality of water in terms of the instream or watershed environment. For each pollutant or stressor addressed in the problem statement, an indicator and target value of that indicator is developed.
Water Quality Objectives	A State Basin Plan term equivalent to the Clean Water Act's water quality criteria. Water quality criteria are limits or levels of water quality constituents or characteristics established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area.
Water Quality Standard	A Clean Water Act term which includes the designated uses of a water, the water quality criteria established to protect the designated uses, and an anti-degradation policy.
Yarding	Collecting of cut timber at a landing area.
Yearling	Fish that hatched during the previous year (i.e., one-year-old).
Young-of-Year	Fish that hatched in the current season.
WY	Water Year. October 1 - September 30. E.g., WY2006 = October 1, 2006 through September 30, 2006.

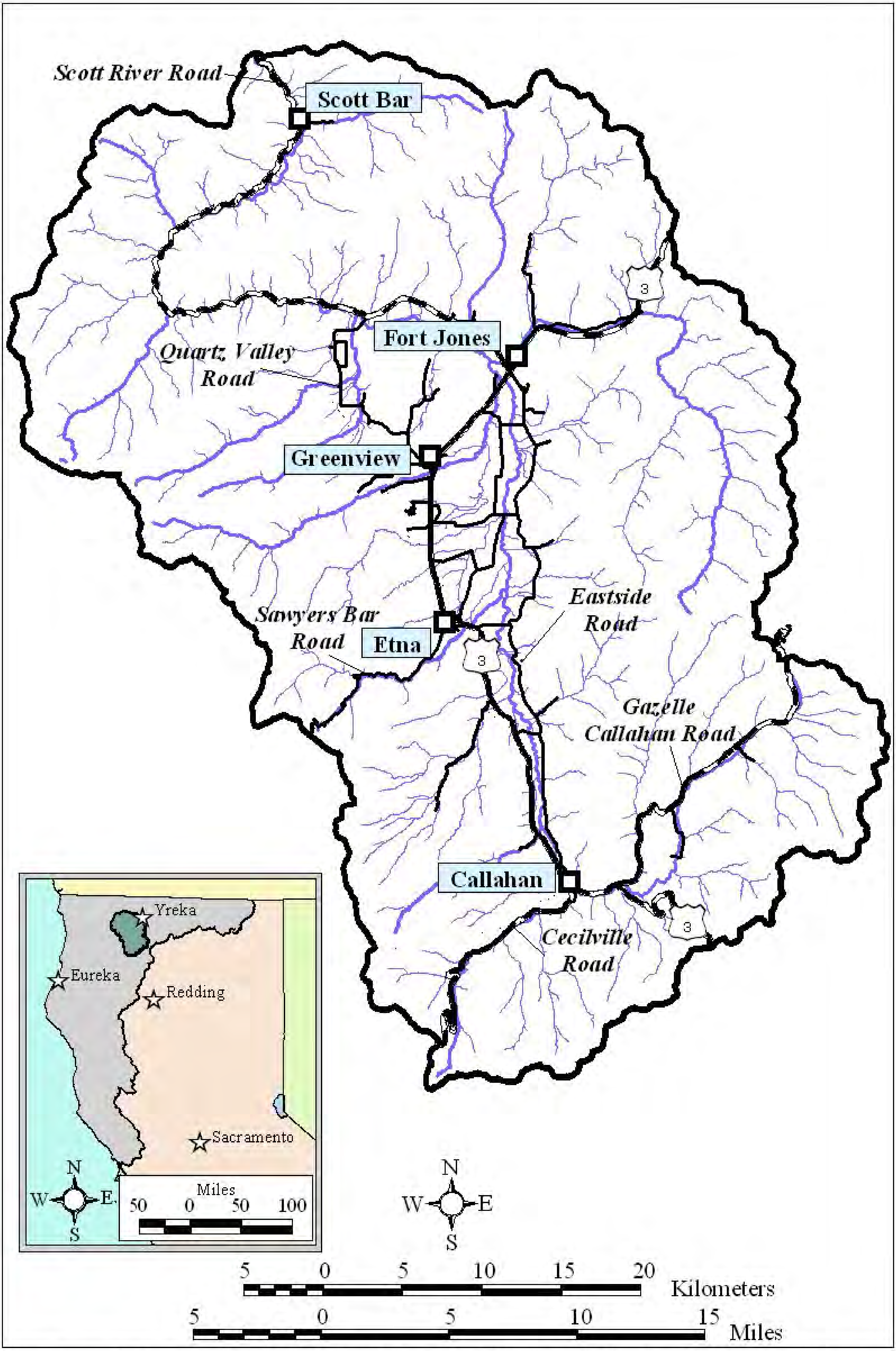

Figure 1.1. Index map showing location of the Scott River watershed and major features within the watershed.

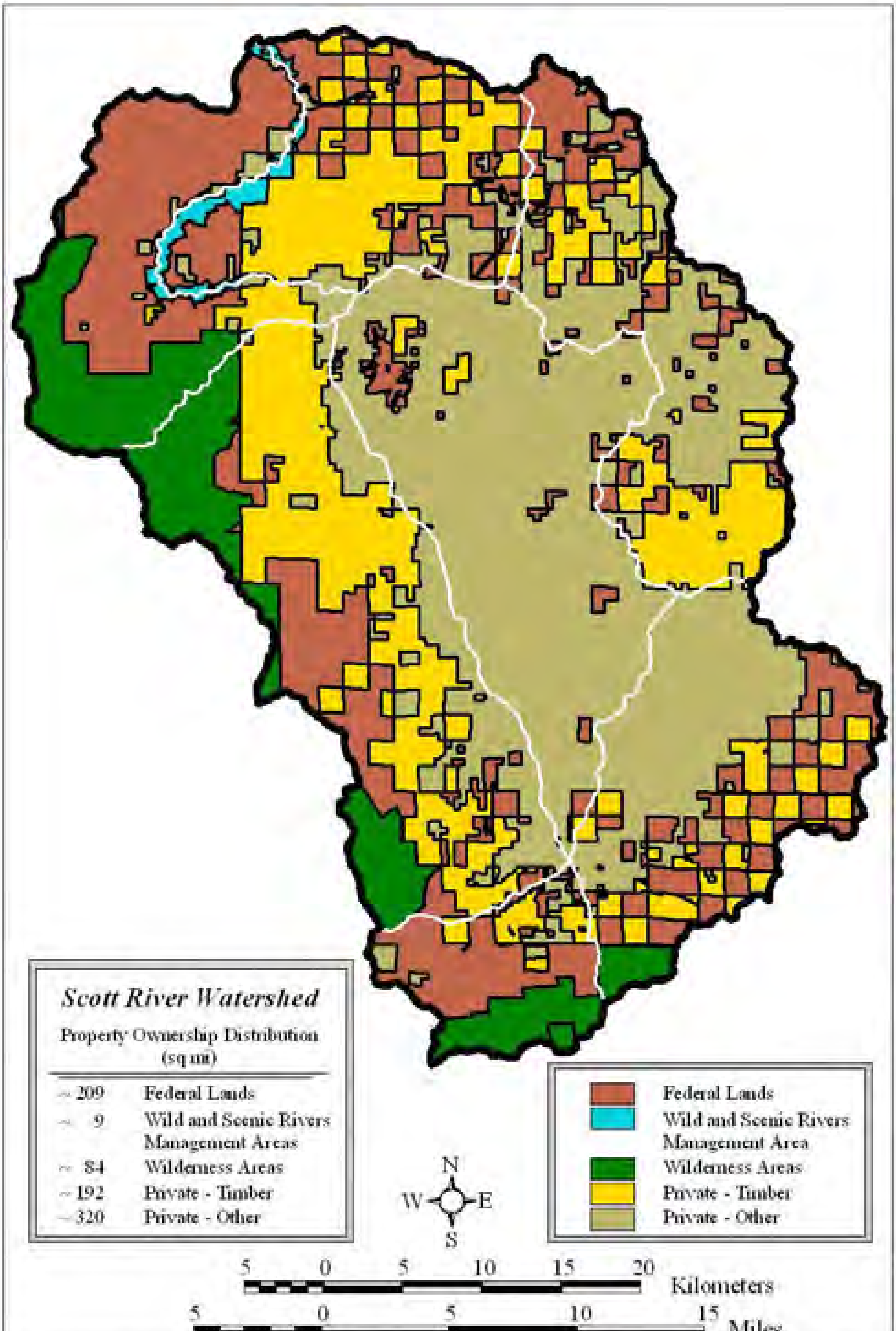

Figure 1.6. Distribution of property ownership in the Scott River watershed

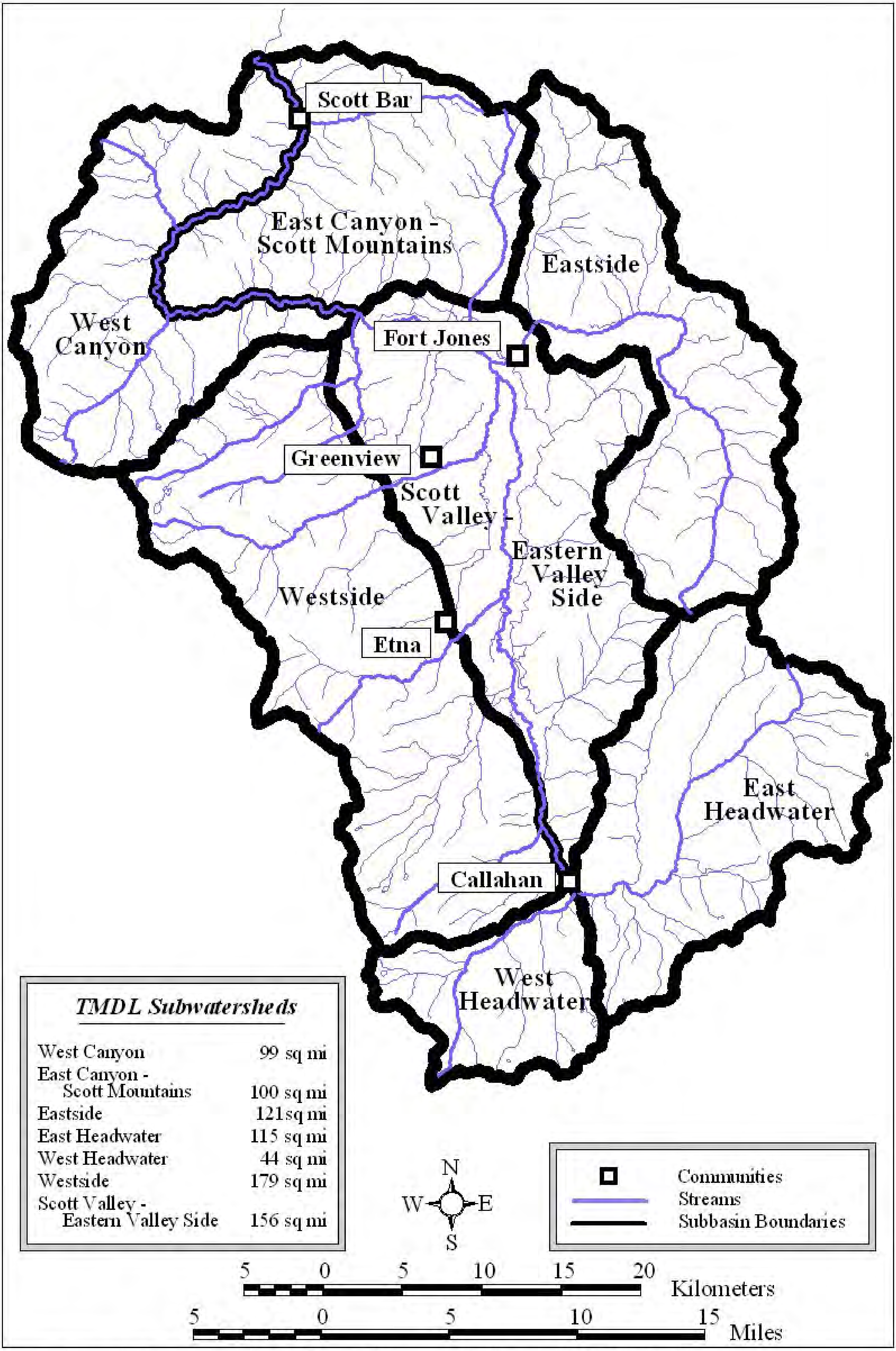

Figure 3.1. Subwatersheds in the Scott River watershed as applied in the Sediment TMDL

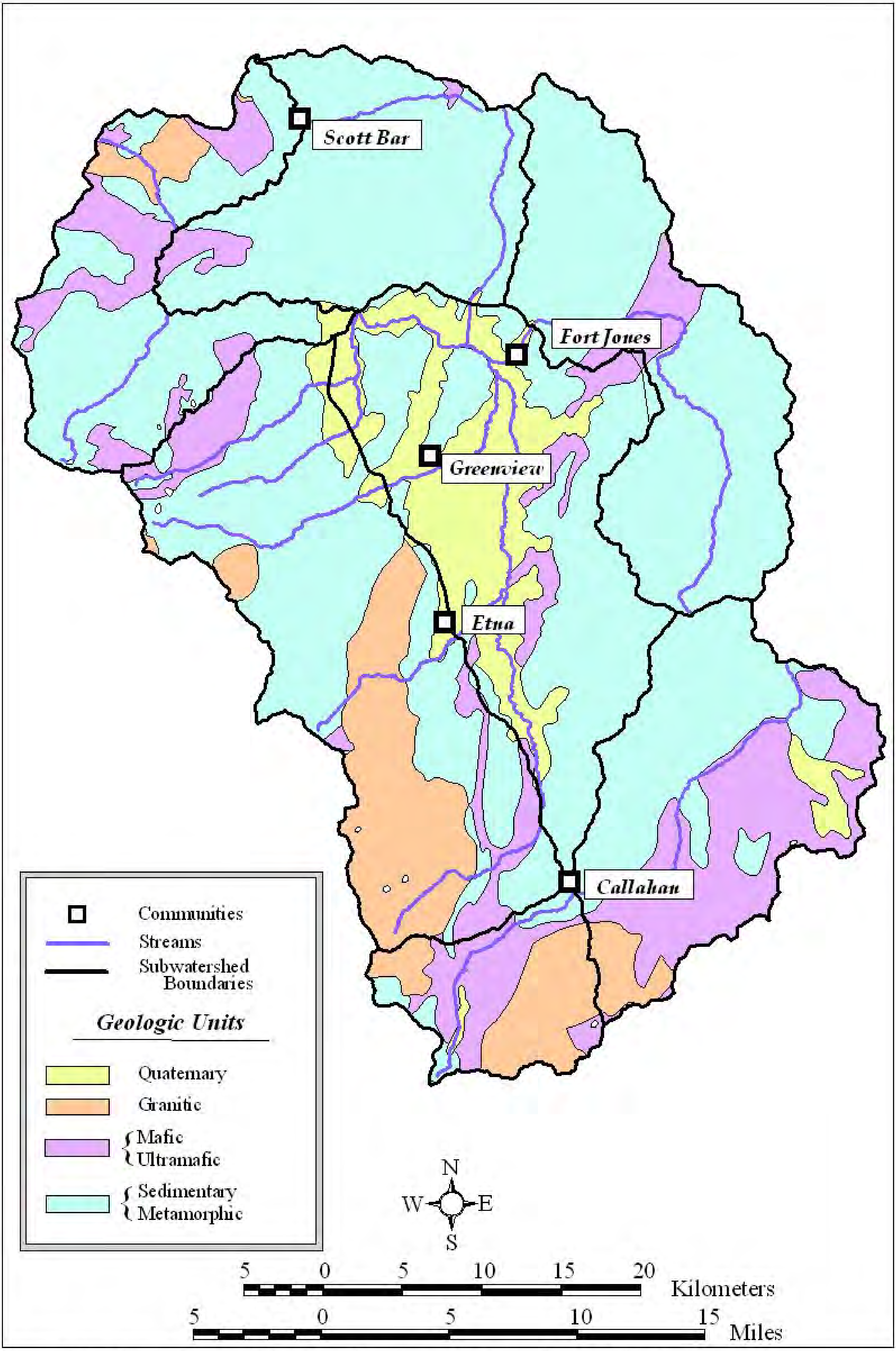

Figure 3.2. Geologic map of the Scott River watershed showing combined geologic units (combined from Saucedo et al., 2000)

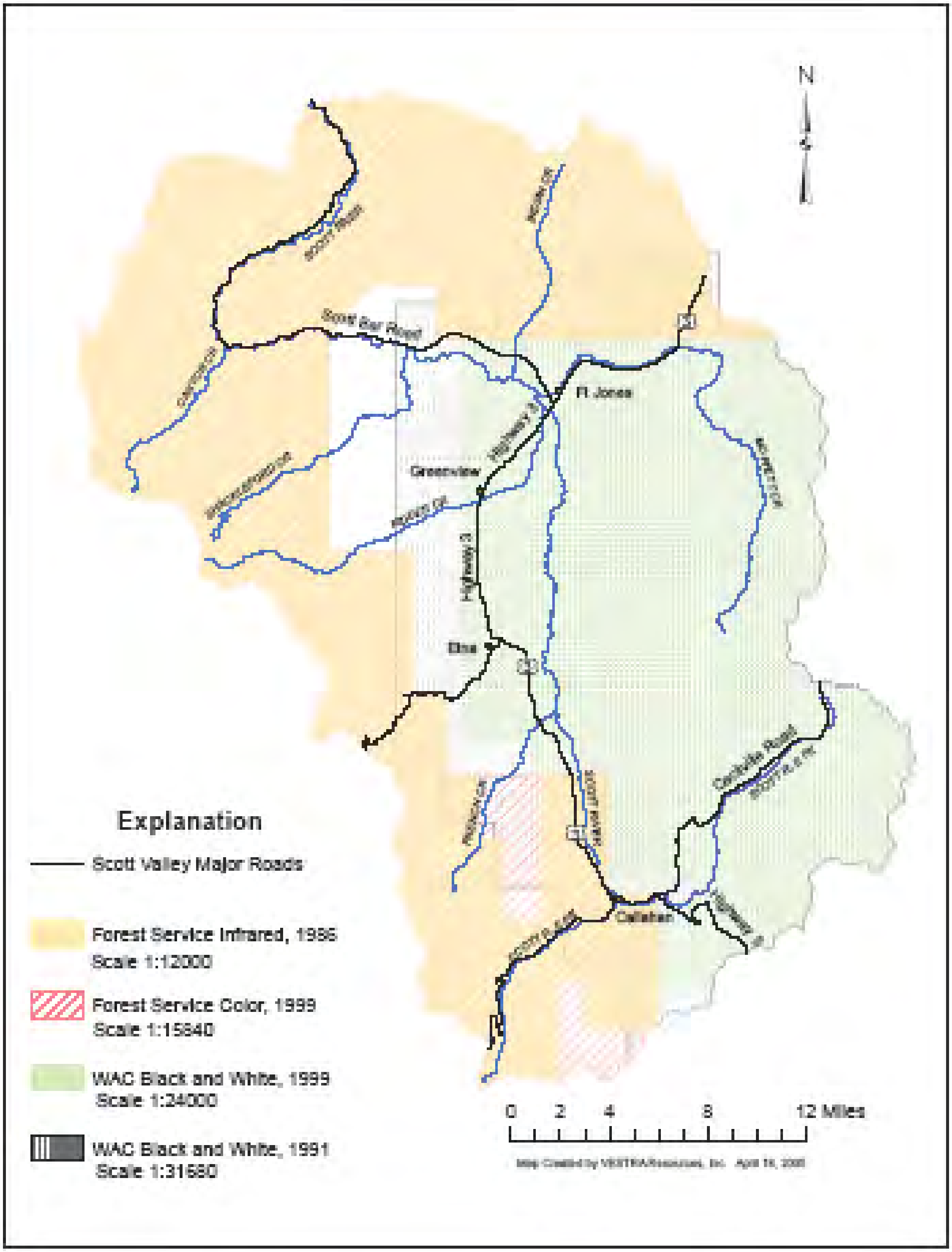

Figure 3.3. Map showing aerial photo coverage used in the Scott River watershed.

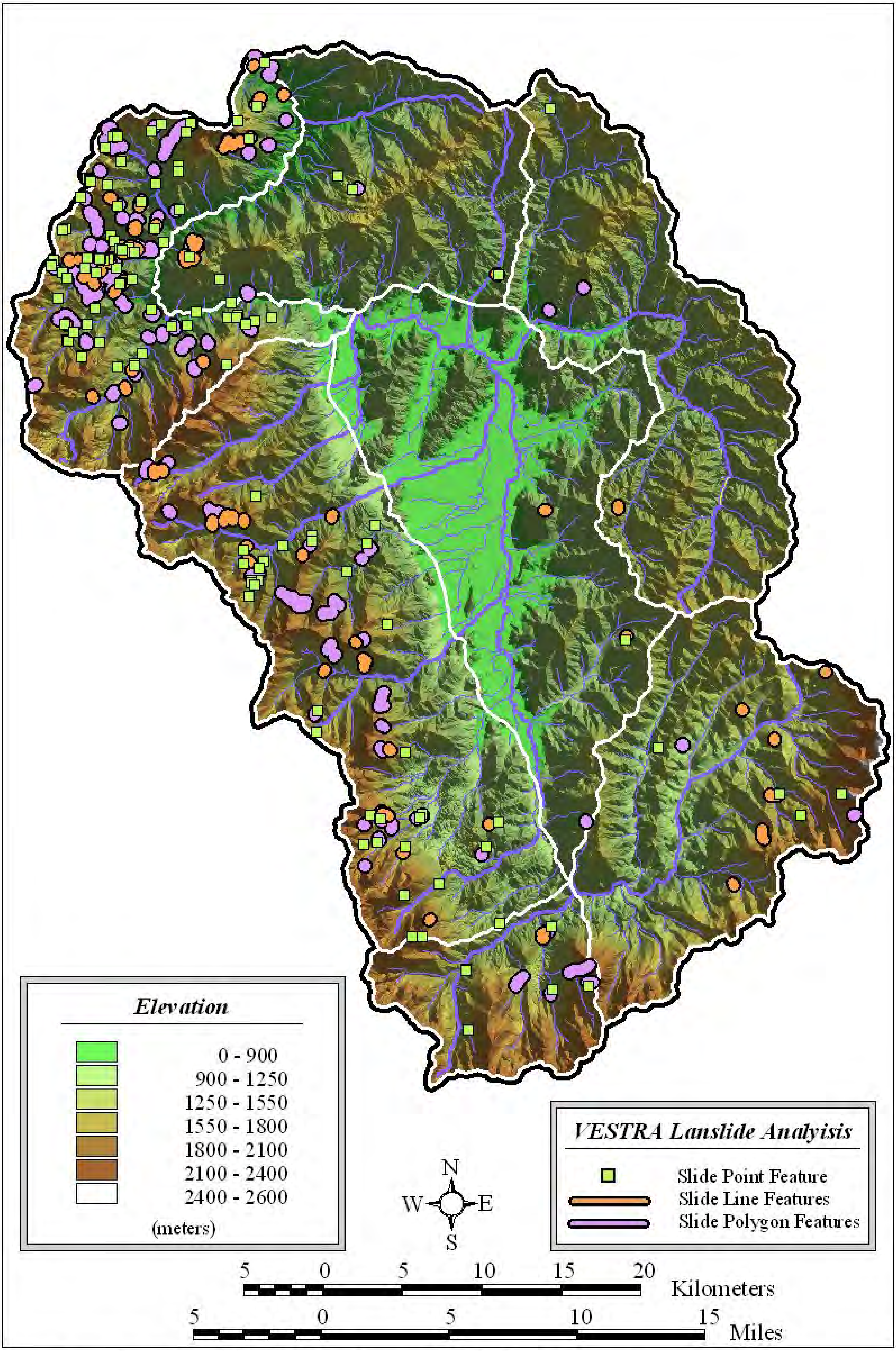

Figure 3.4 Locations of landslides in photo-analysis by Vestra Resources

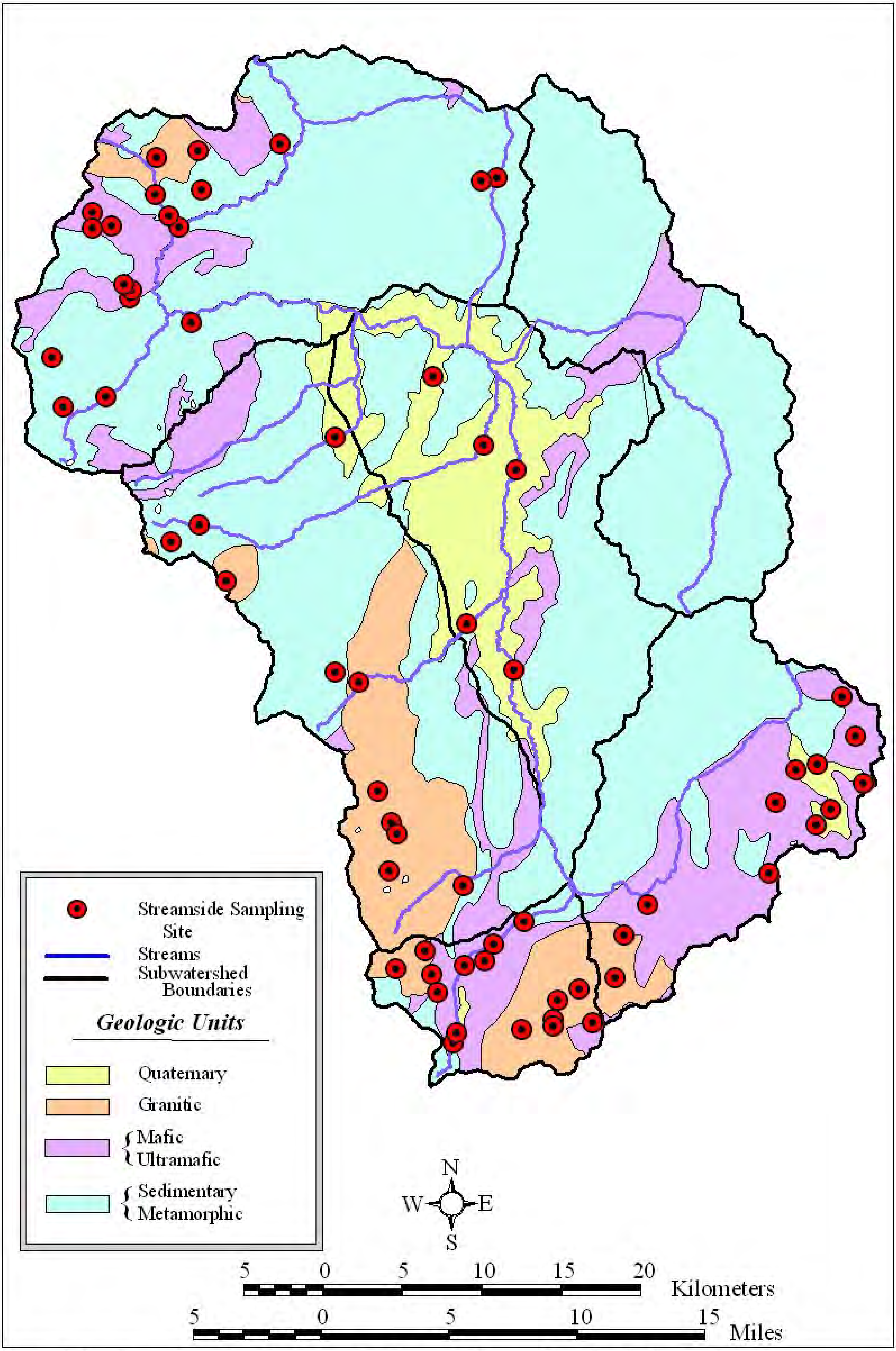

Figure 3.5. Locations of randomly stratified streamside sampling sites in the Scott River watershed as conducted by Regional Water Board staff 2003-2004

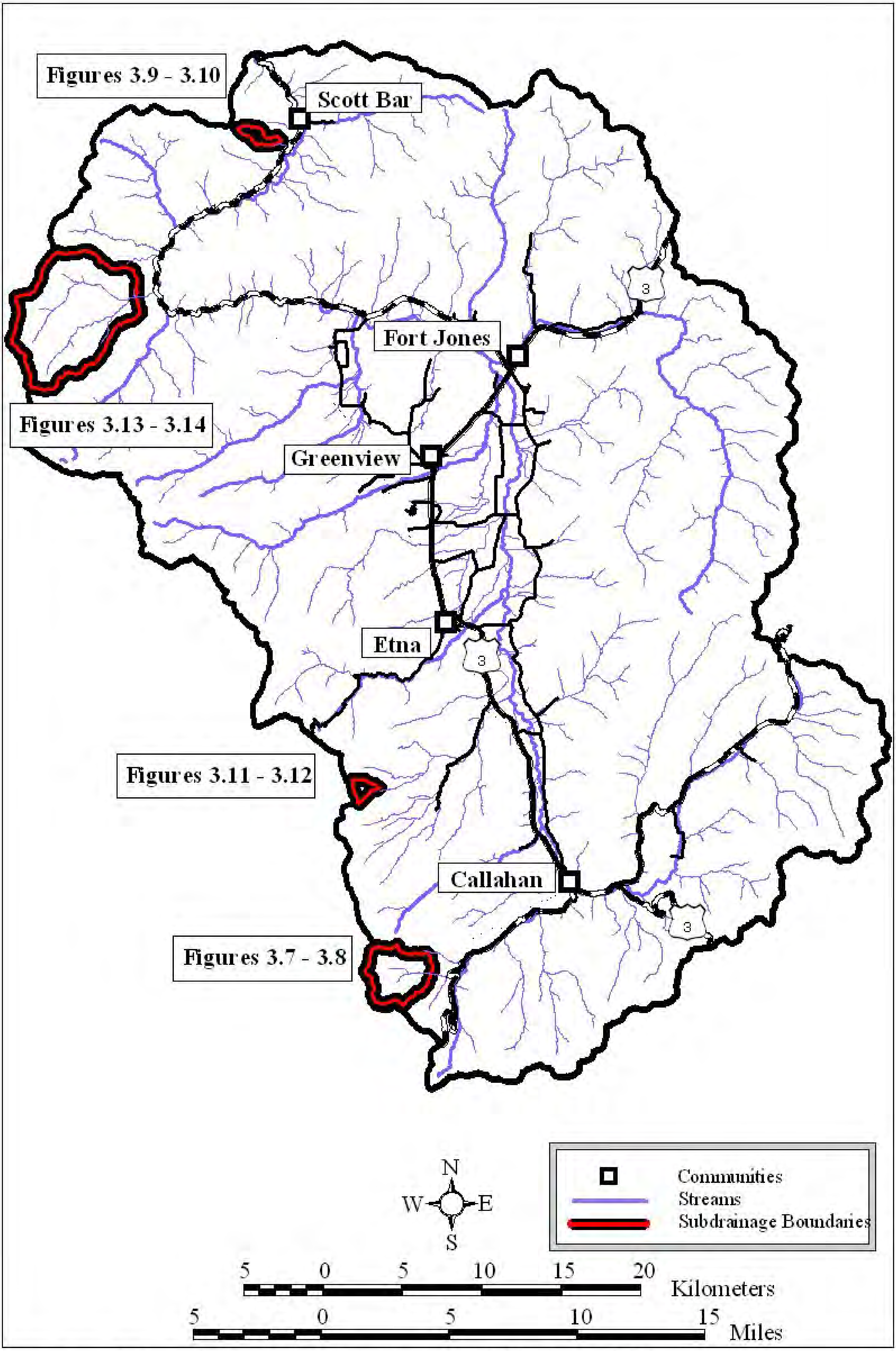

Figure 3.6. Index map showing location of areas detailed in Figures 3.6 through 3.14.

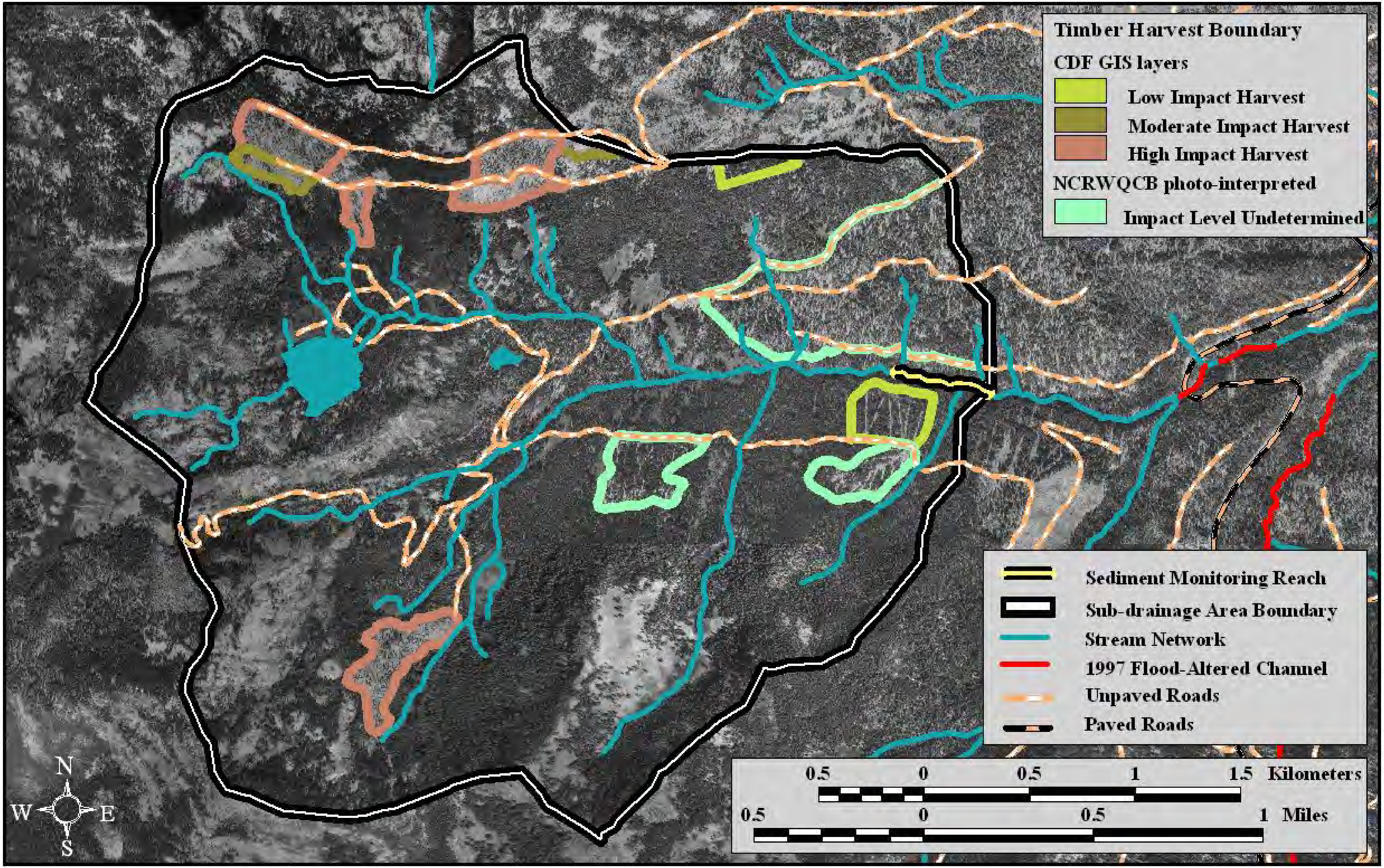

Figure 3.7. Orthophoto with GIS and photointerpretation coverage showing disturbance history in an area where human-caused sediment delivery is interpreted to be in the zero percent category. Jackson Creek.

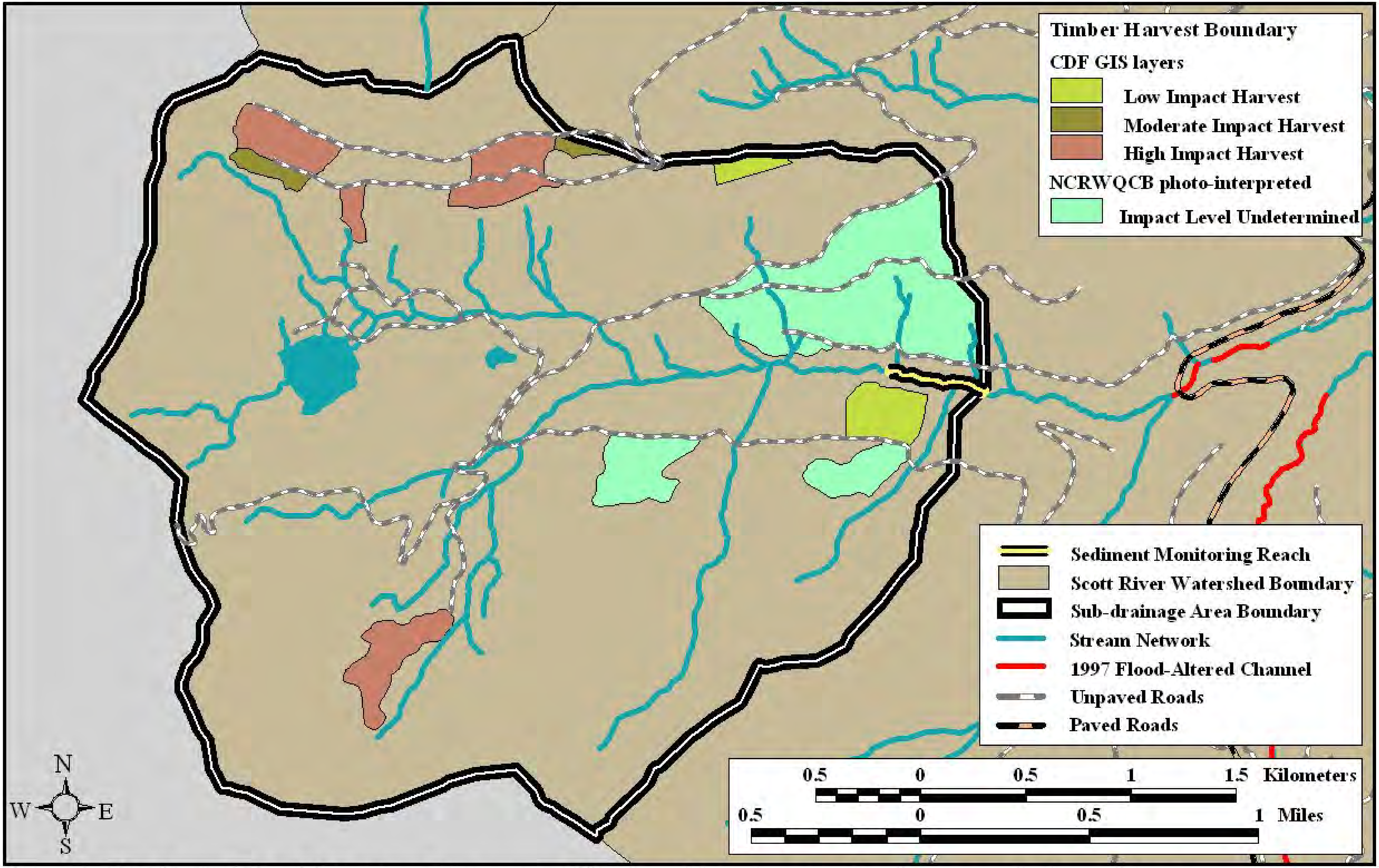

Figure 3.8. Map showing GIS and photointerpretation coverage of disturbance history in an area where human-caused sediment delivery is interpreted to be in the zero percent category. Jackson Creek

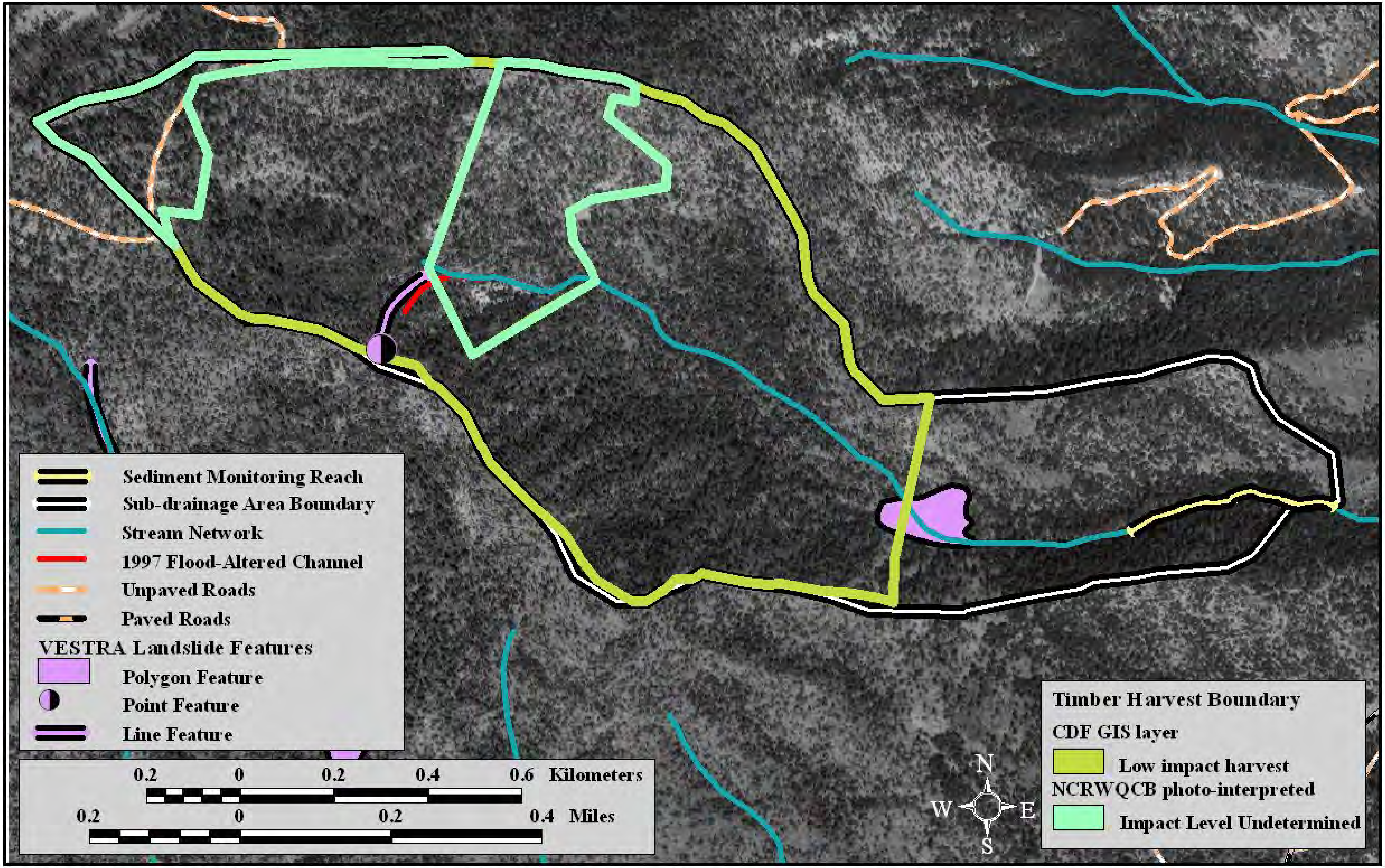

Figure 3.9. Orthophoto with GIS and photointerpretation coverage showing disturbance history in an area where human-caused sediment delivery is interpreted to be in the 25 percent category. Unnamed tributary to Scott River.

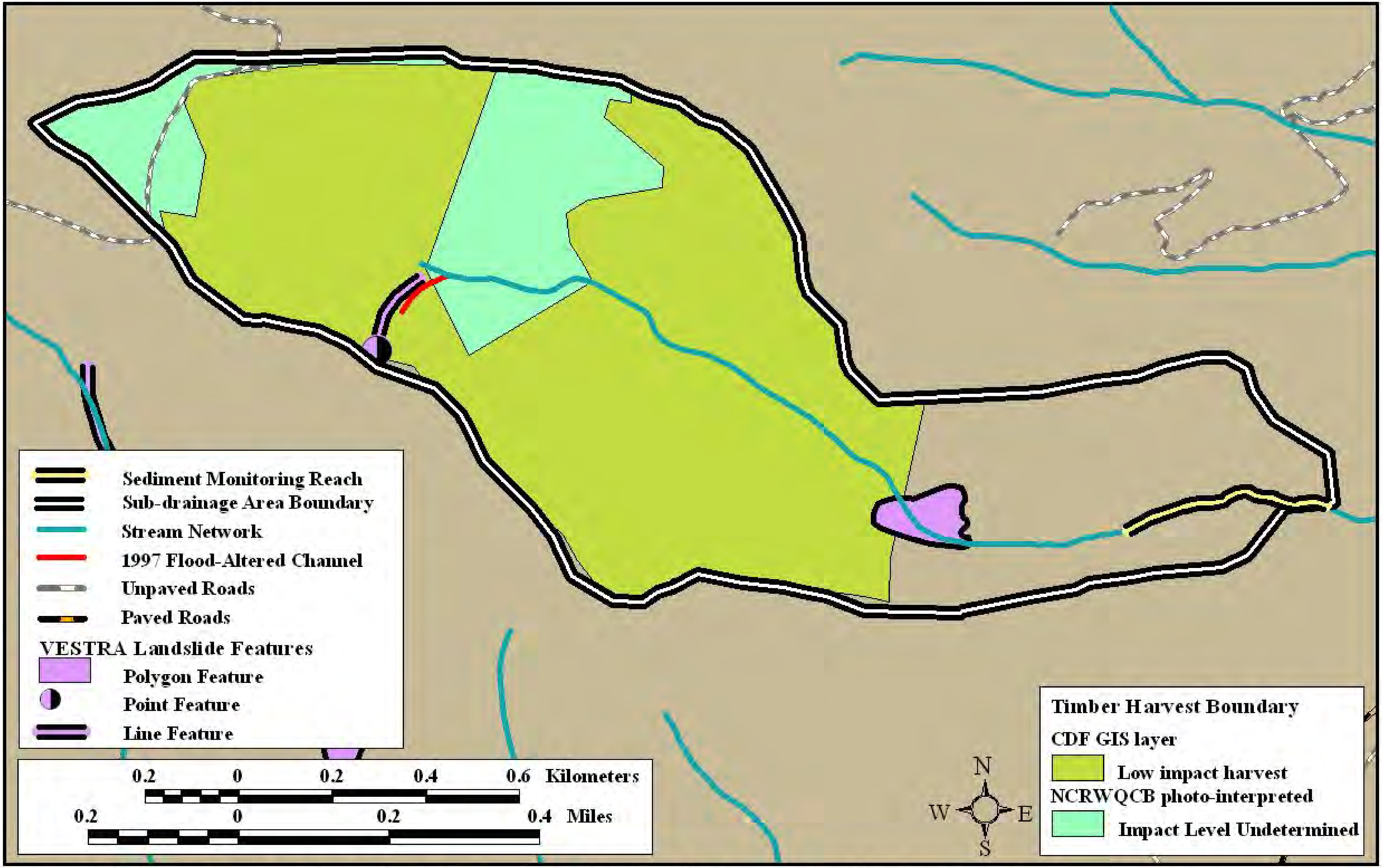

Figure 3.10. Map showing GIS and photointerpretation coverage of disturbance history in an area where human-caused sediment delivery is interpreted to be in the 25 percent category. Unnamed tributary to the Scott River.

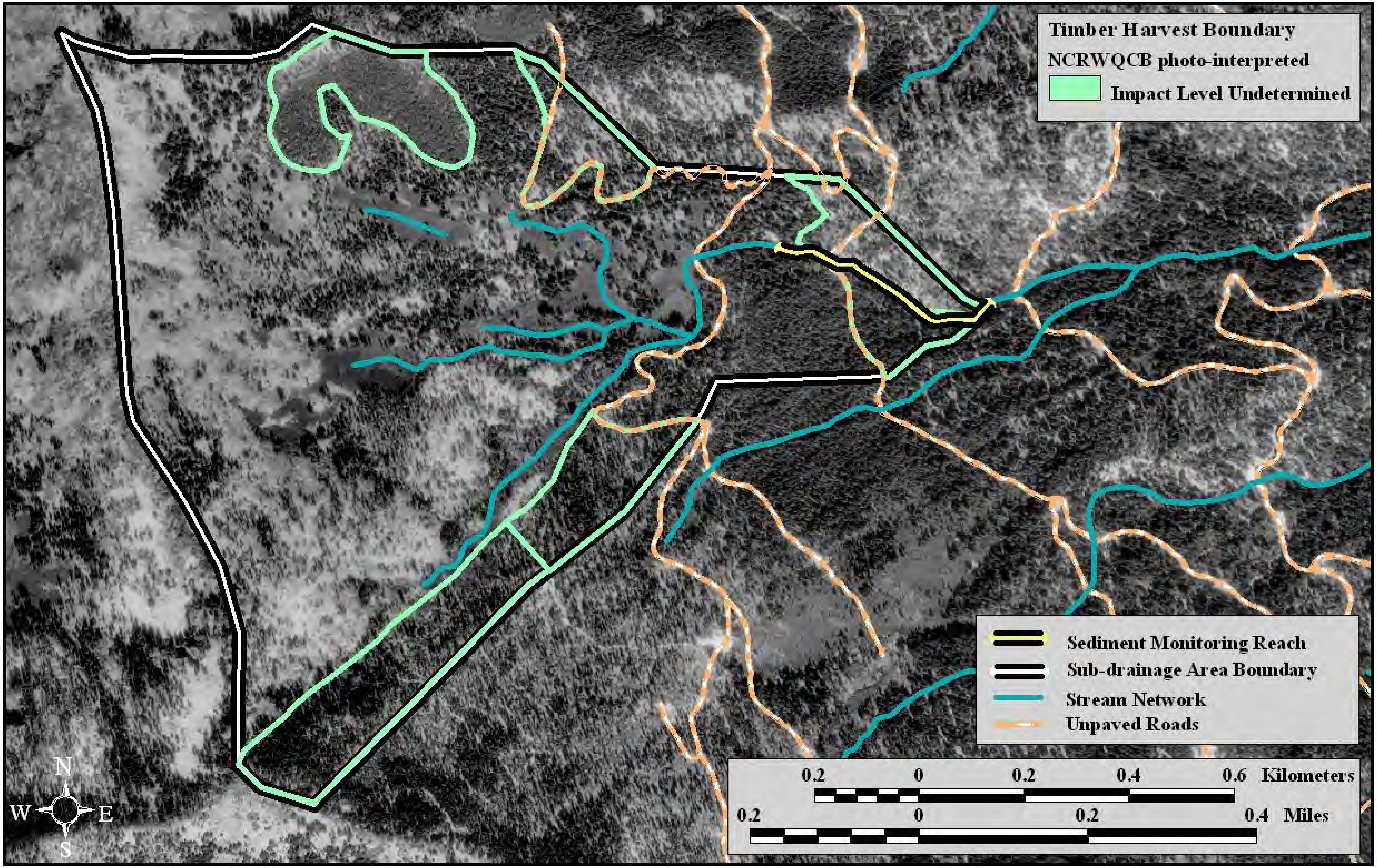

Figure 3.11. Orthophoto with GIS and photointerpretation coverage showing disturbance history in an area where human-caused sediment delivery is interpreted to be in the 50 percent category. North Fork French Creek.

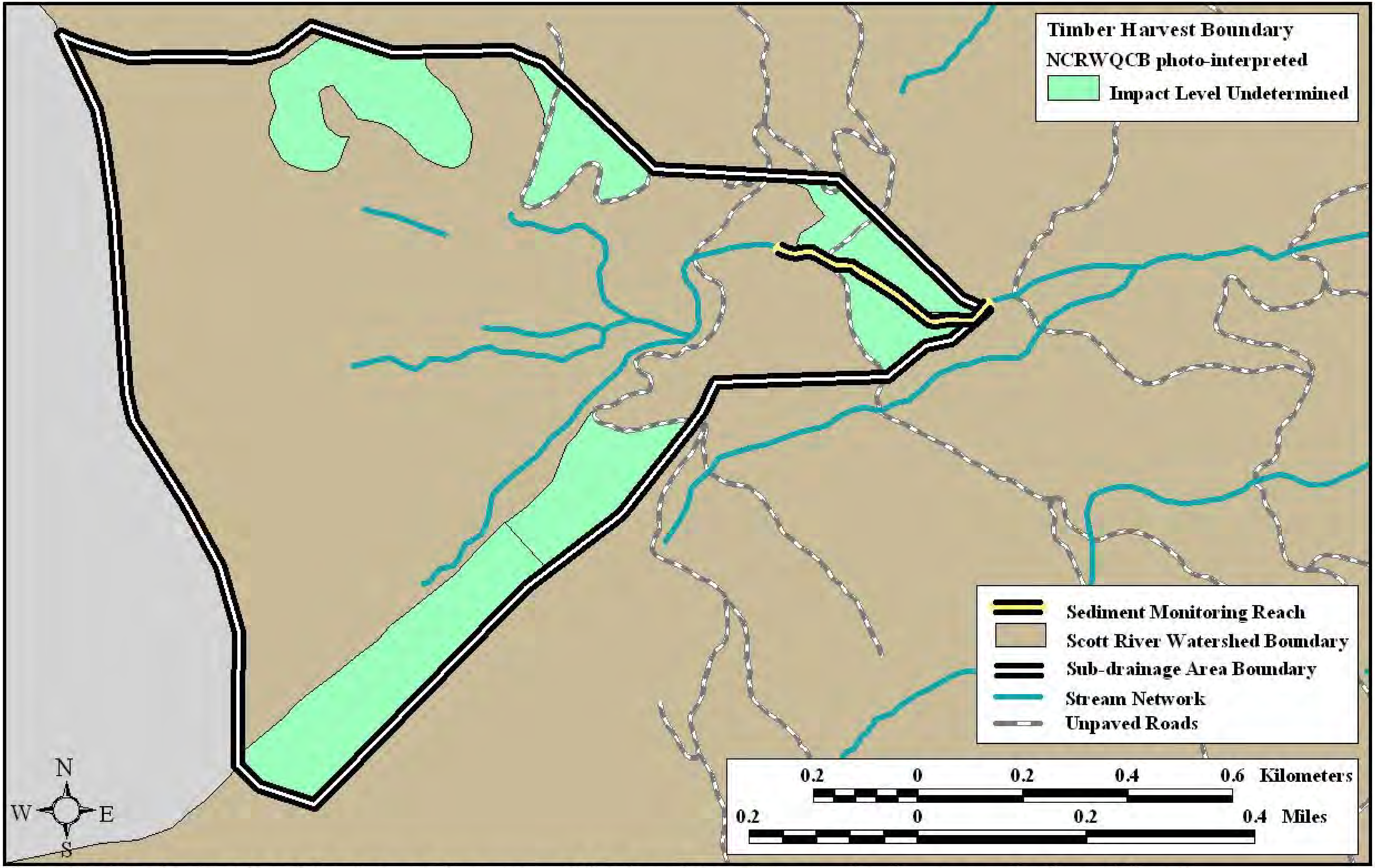

Figure 3.12. Map showing GIS and photointerpretation coverage of disturbance history in an area where human-caused sediment delivery is interpreted to be in the **50** percent category. North Fork French Creek.

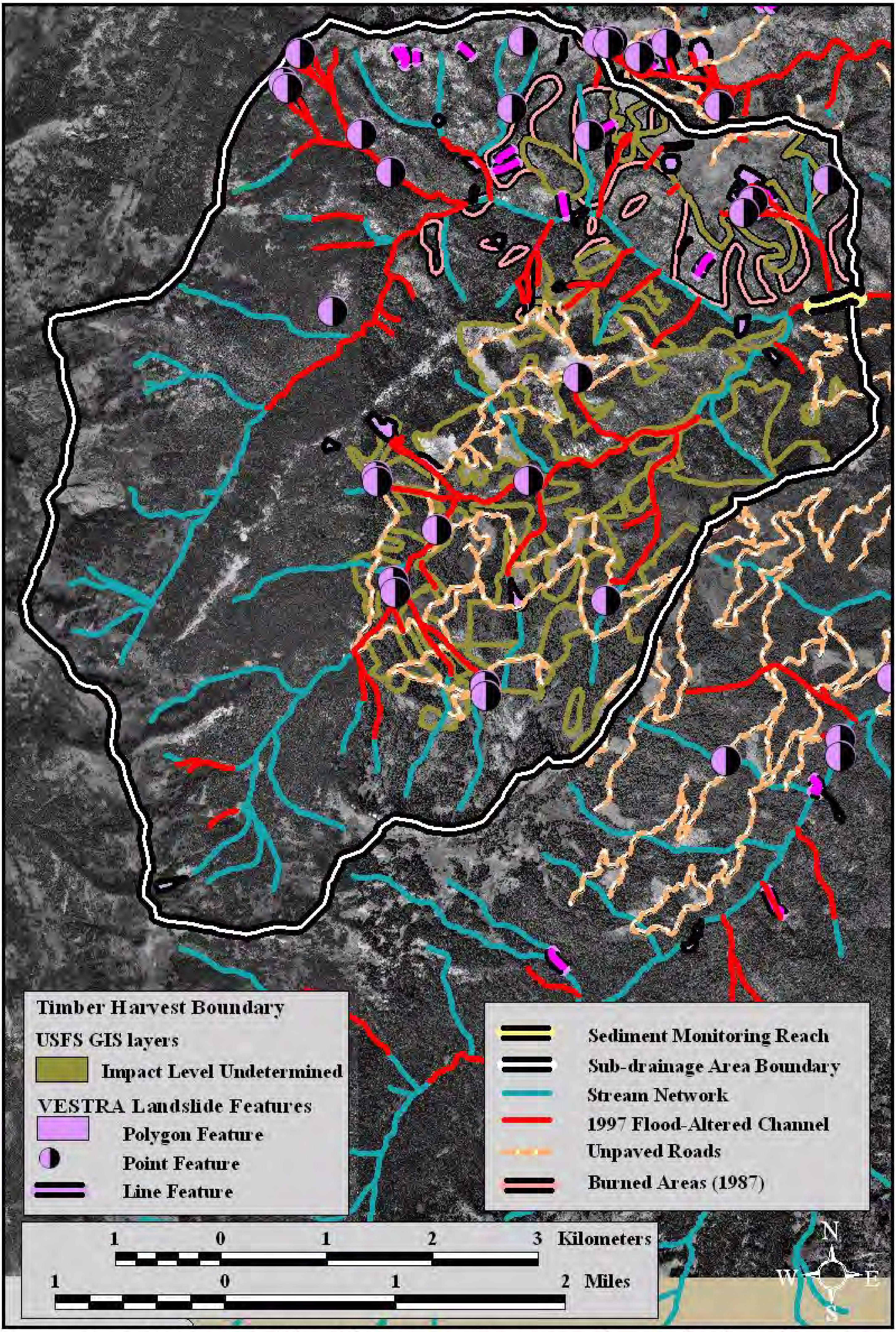

Figure 3.13. Orthophoto with GIS and photointerpretation coverage showing disturbance history in an area where human-caused sediment delivery is interpreted to be in the 75 percent category. North Fork Kelsey Creek.

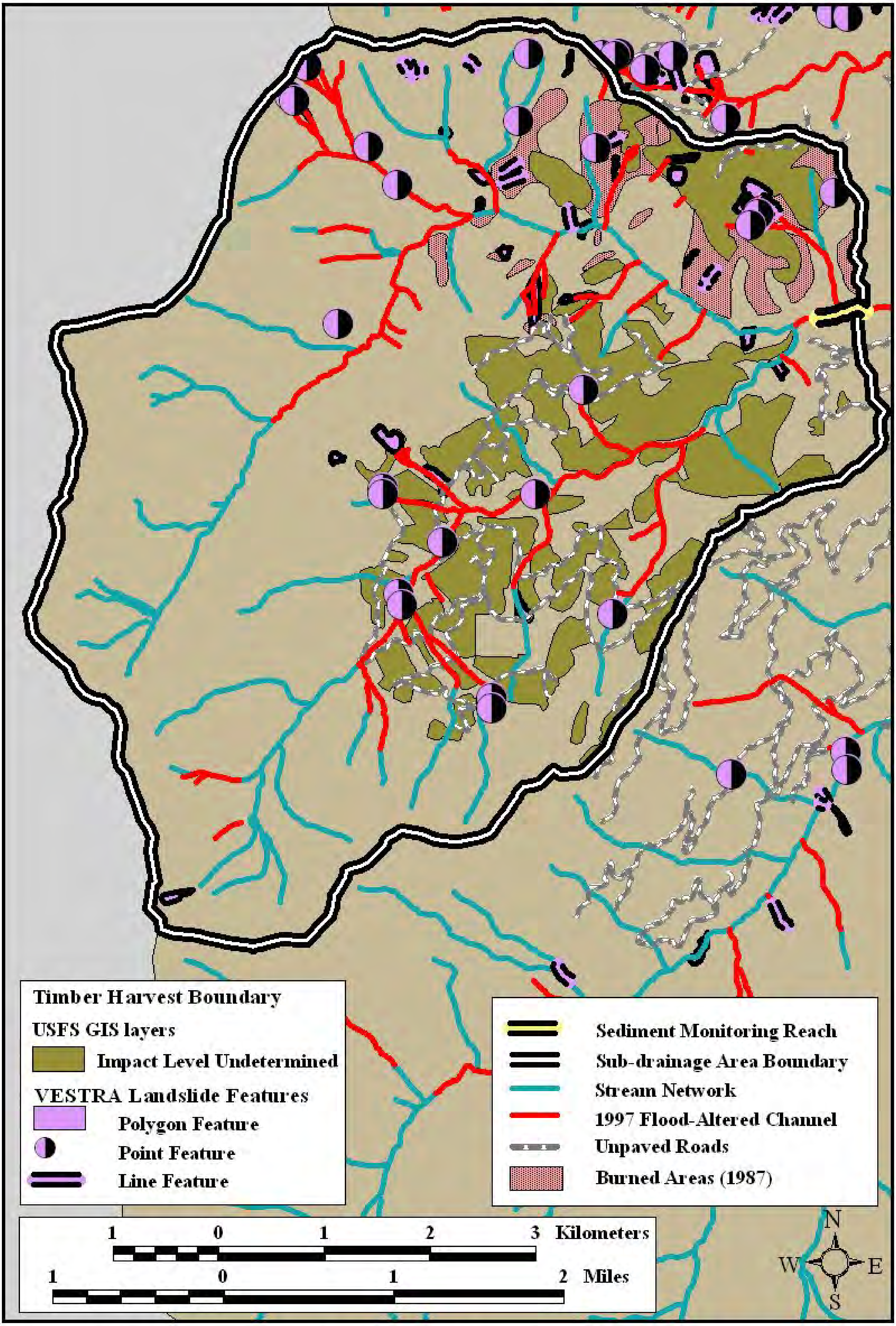

Figure 3.14. Map showing GIS and photointerpretation coverage of disturbance history in an area where human-caused sediment delivery is interpreted to be in the 75 percent category. North Fork Kelsey Creek.

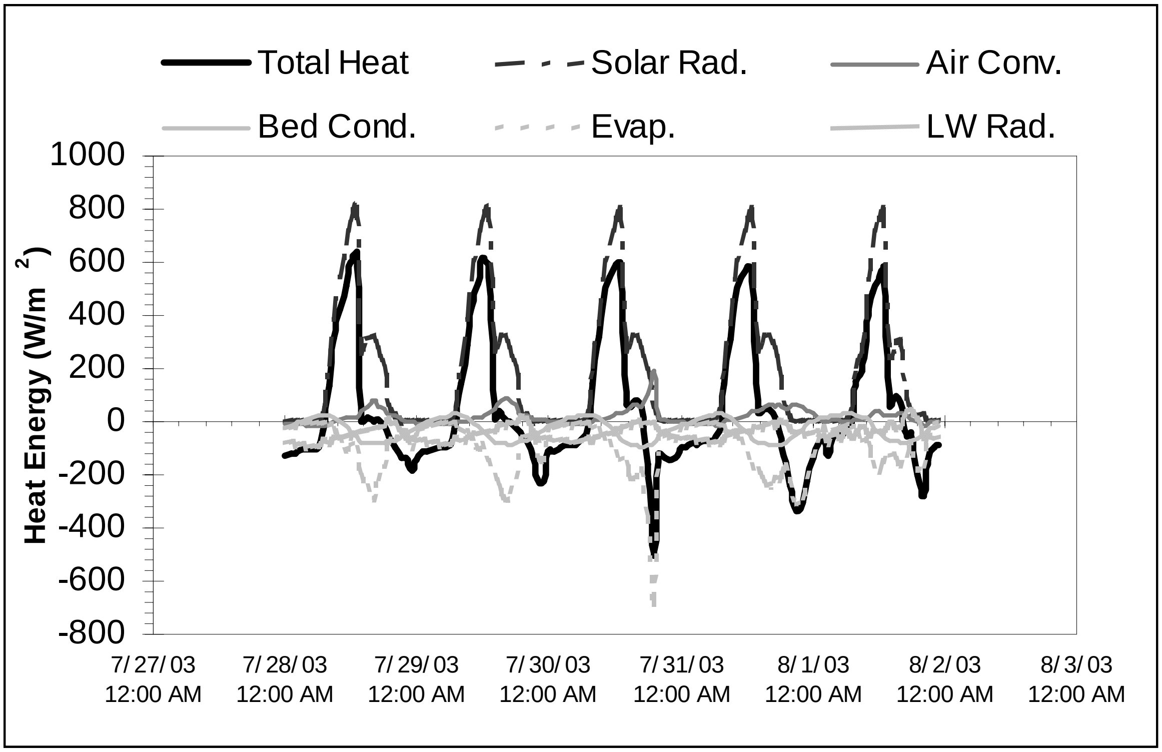

Figure 4.1 A: Daily heat flux, Scott River at Island Road (river kilometer 56.5)

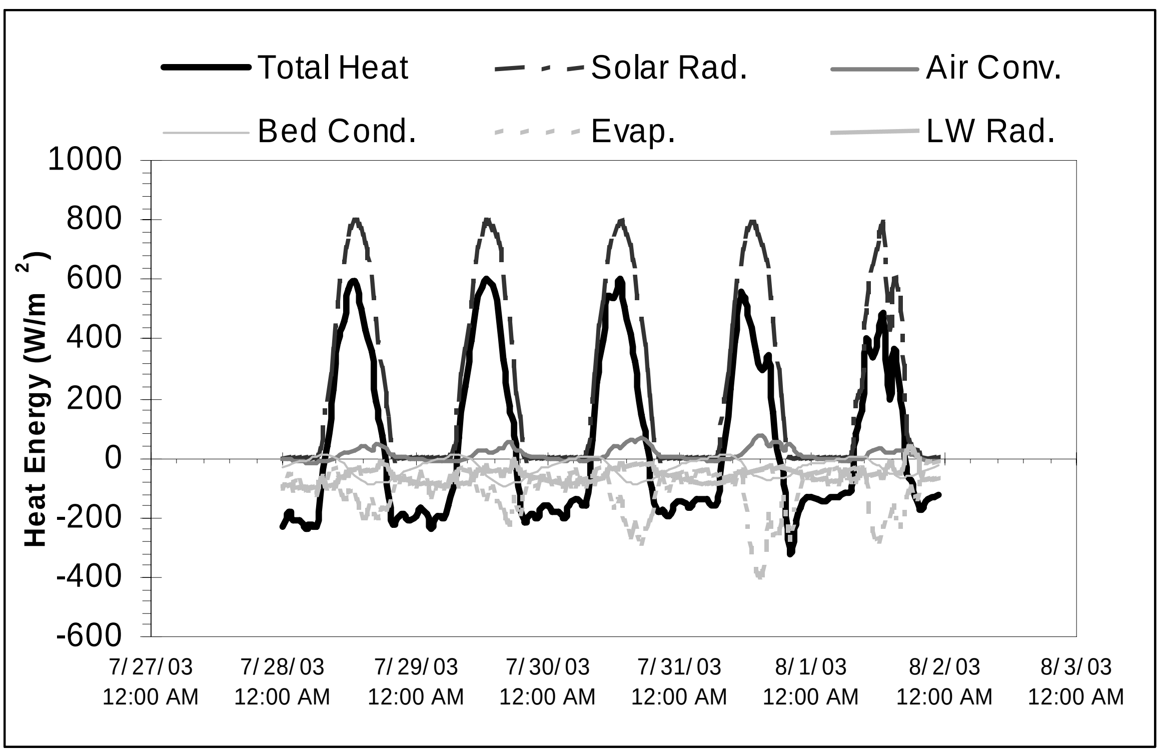

Figure 4.1 B: Daily heat flux, Scott River at Jones Beach (river kilometer 30.0)

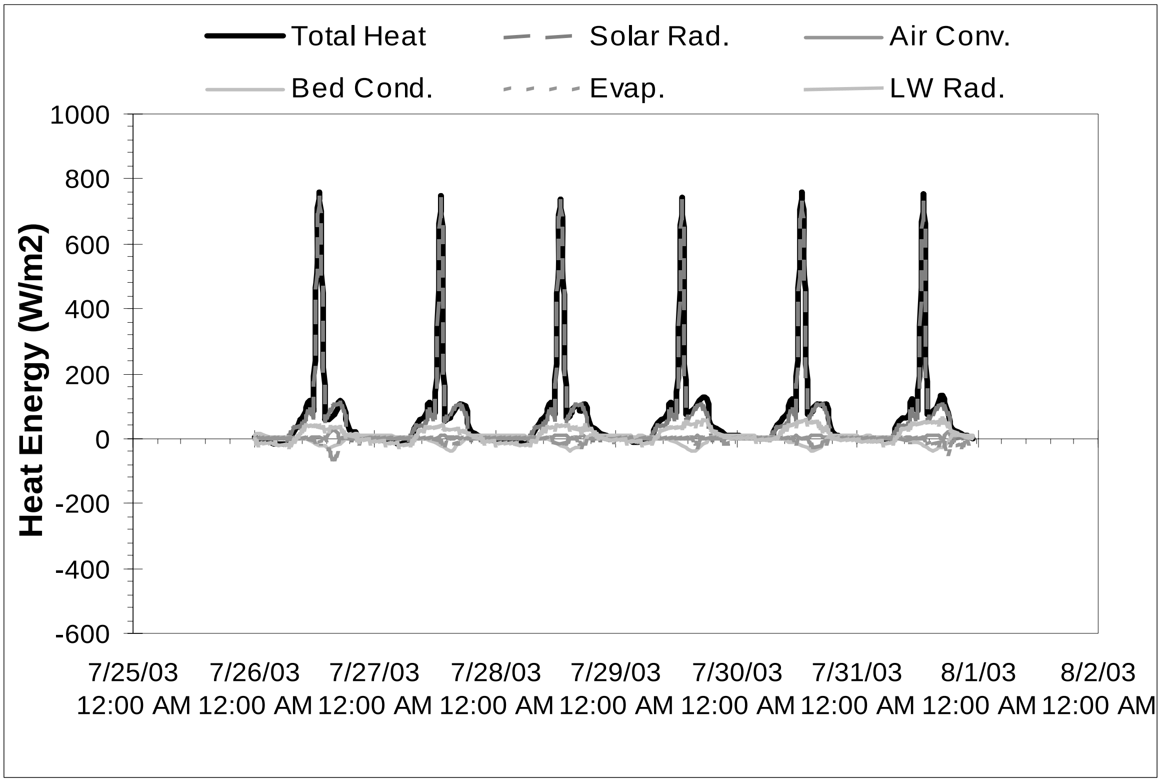

Figure 4.1 C: Daily heat flux, South Fork Scott River downstream of Blue Jay Creek (river kilometer 7.5)

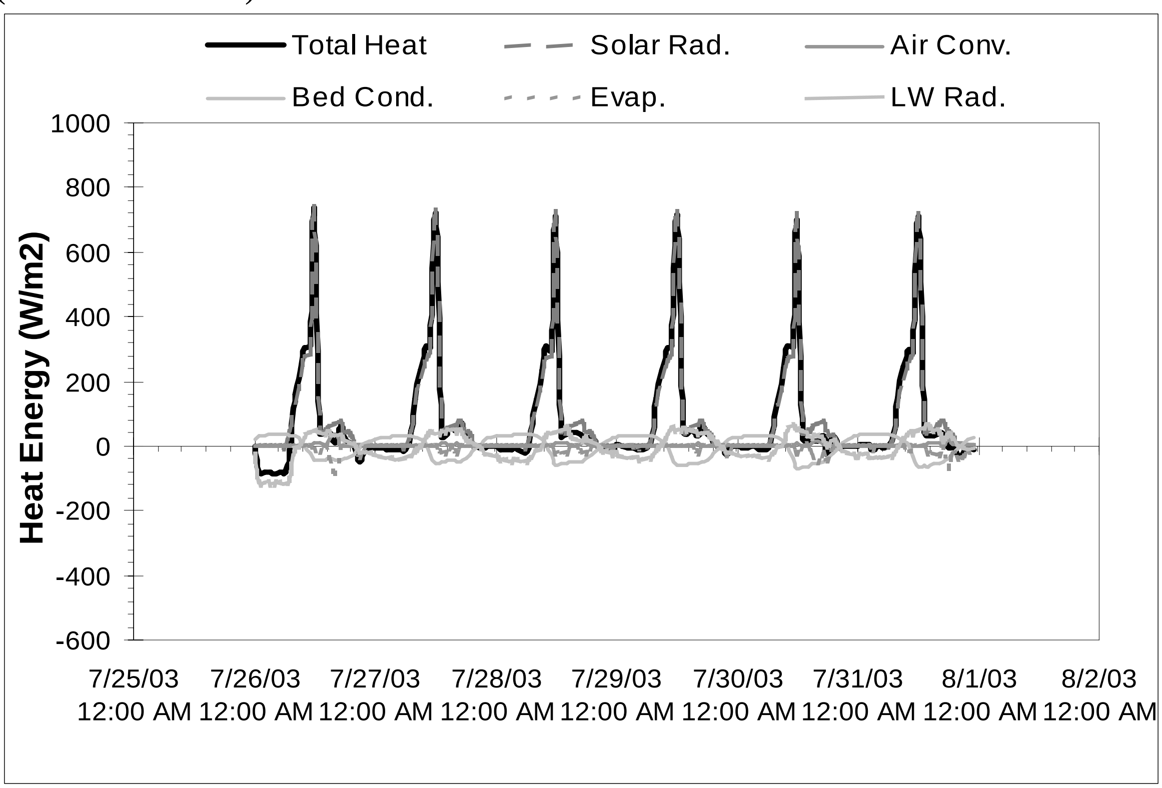

Figure 4.1 D: Daily heat flux, South Fork Scott River upstream of Highway 3 (river kilometer 0.3)

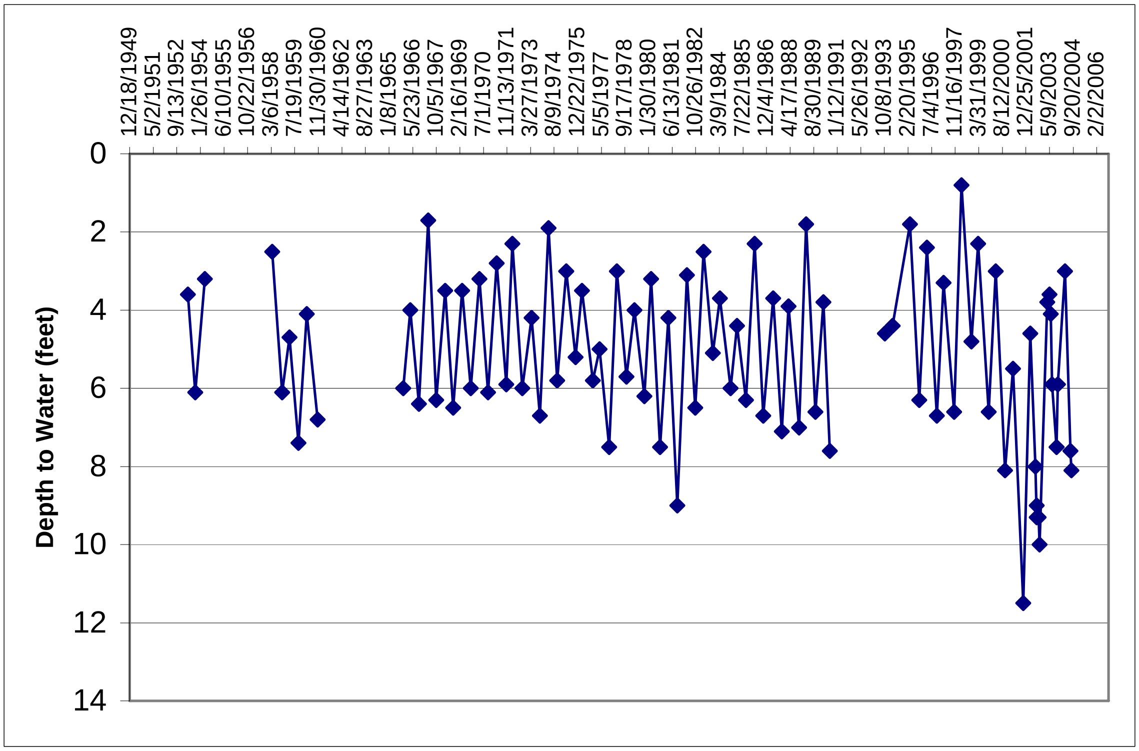

Figure 4.2: Water Table Measurements, Scott Valley

Figure 4.3A: Scott River at River Mile 3.1 to 3.9

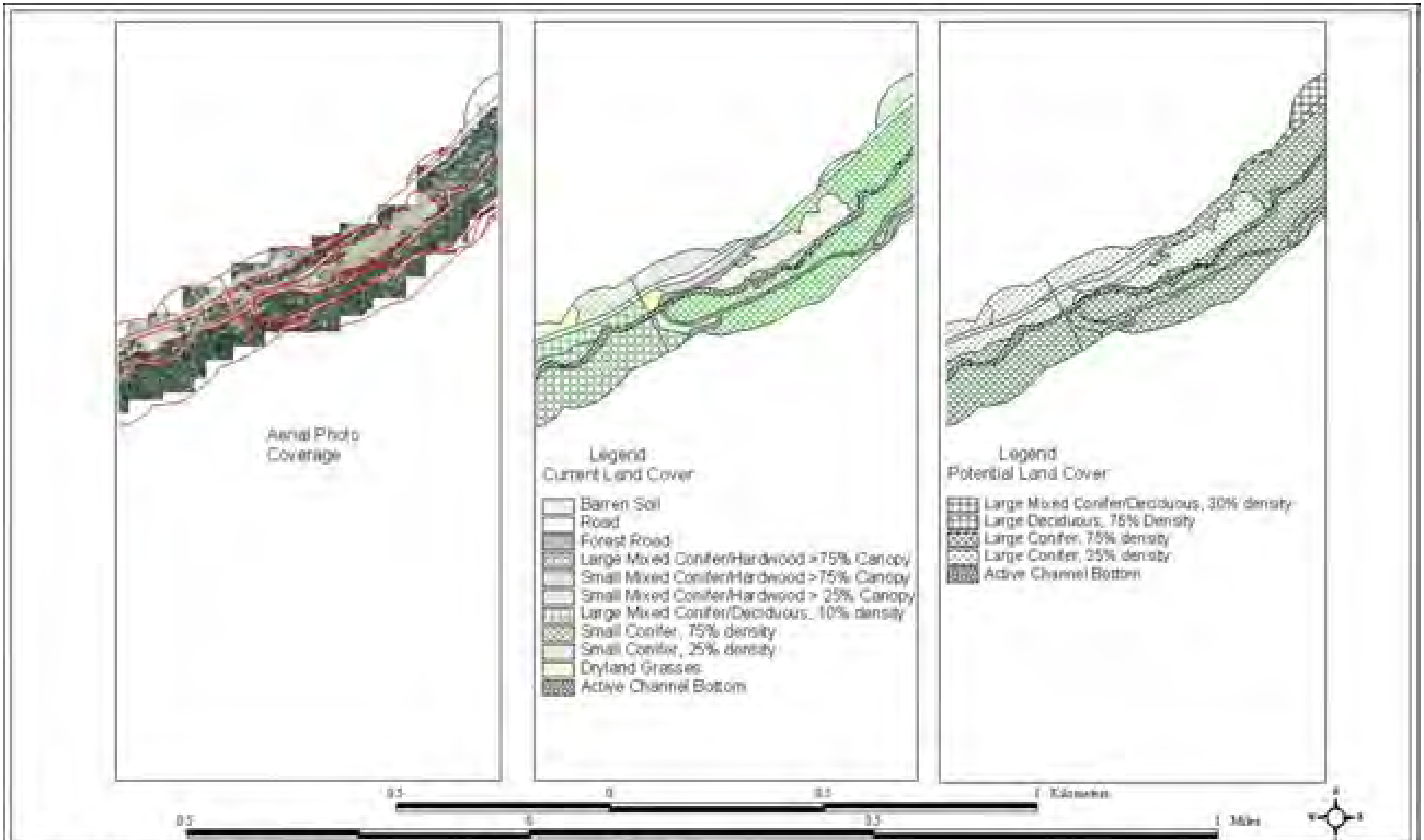

Figure 4.3B: South Fork of the Scott River at River Mile 4.7 to 5.3

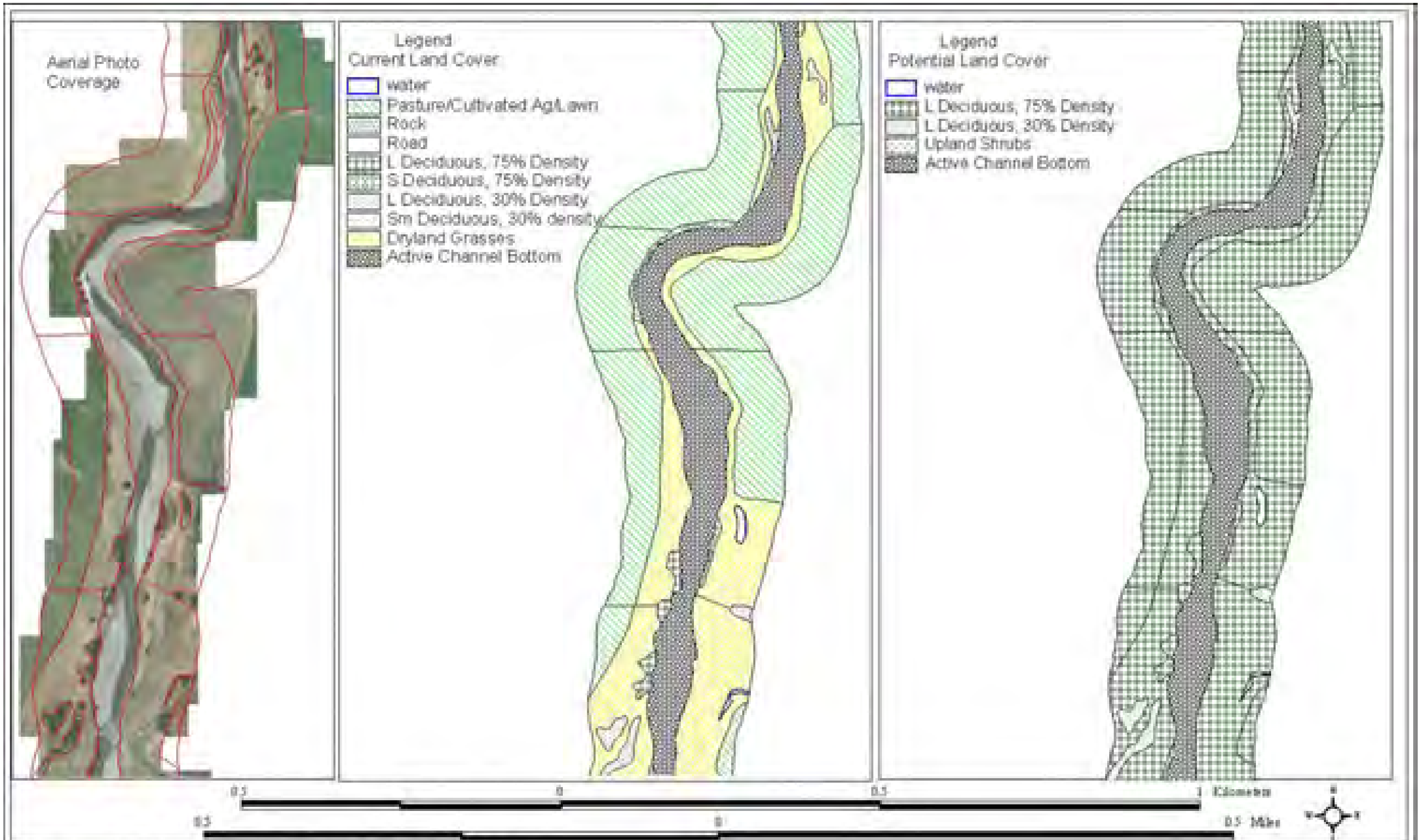

Figure 4.3C: Scott River at River Mile 39.6 to 40.6

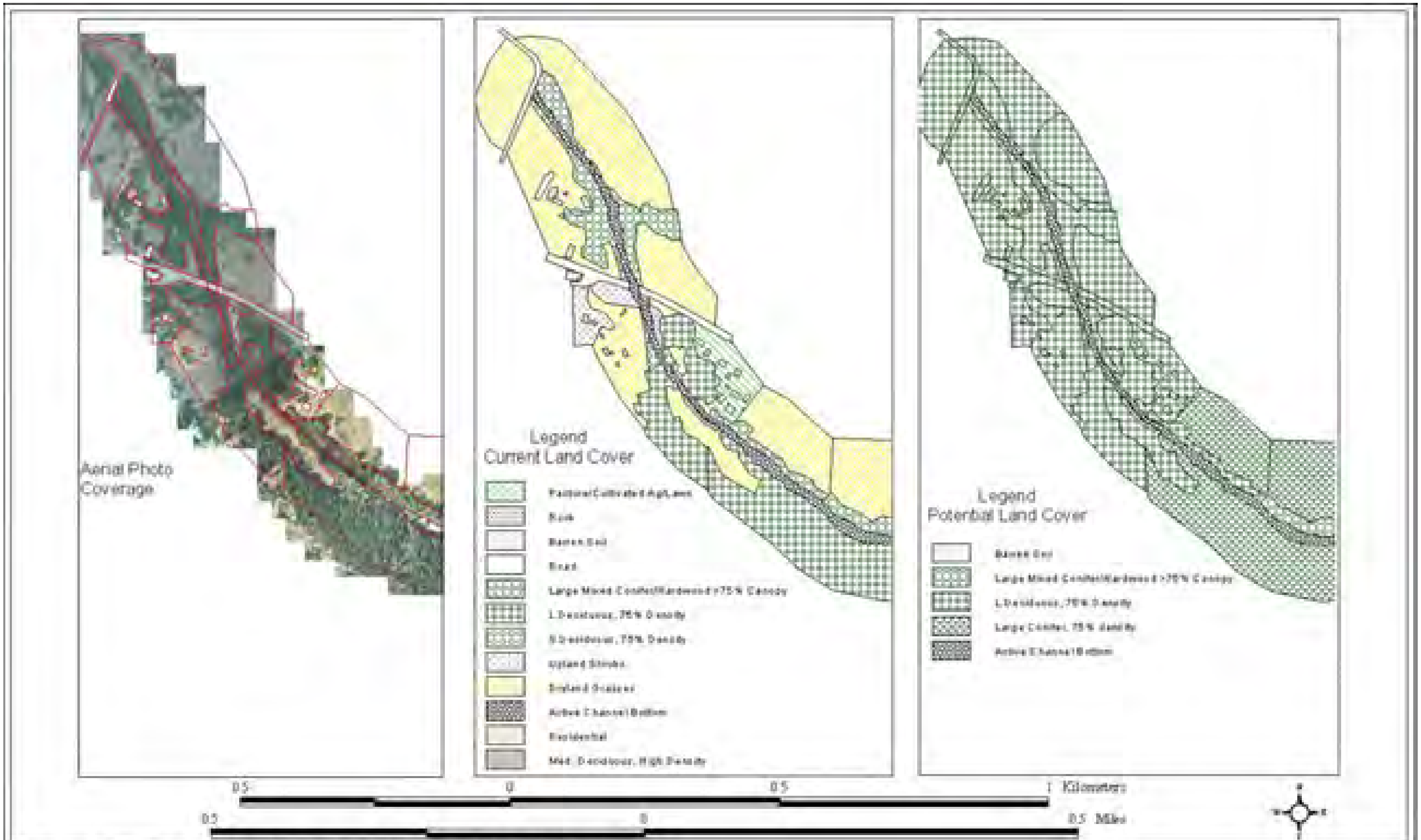

Figure 4.3D: East Fork of the Scott River at River Mile 3.1 to 3.9

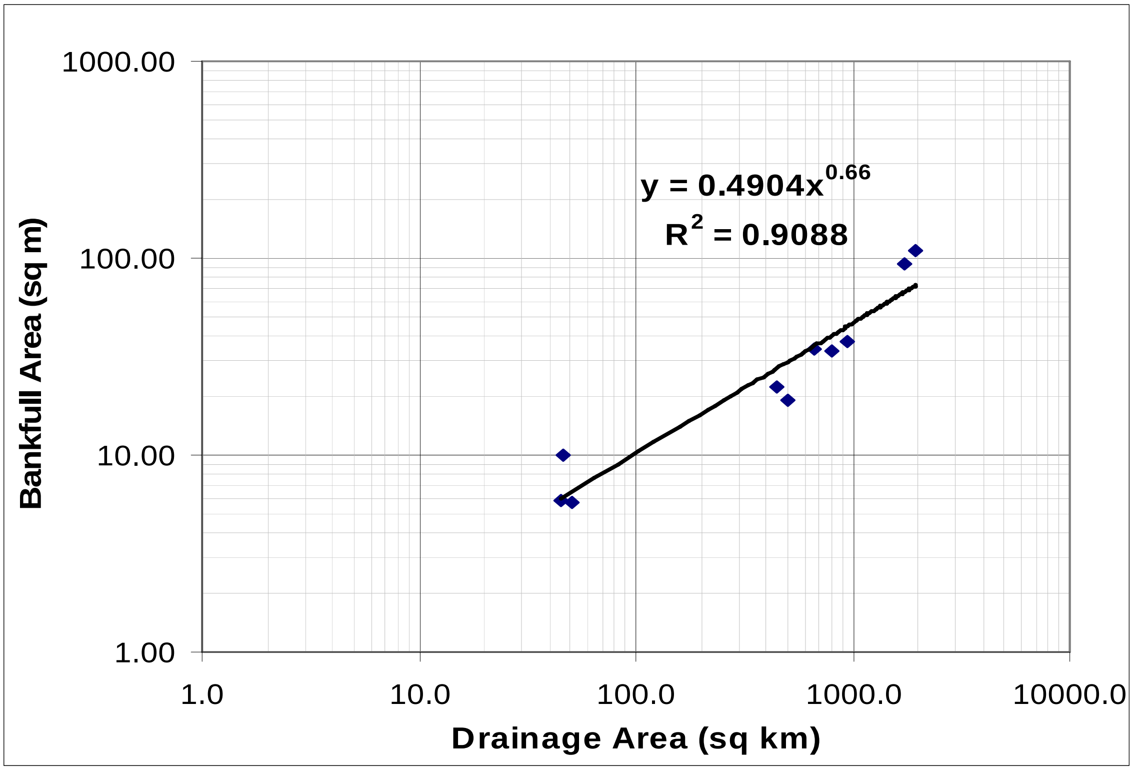

Figure 4.4: Scott River bankfull area-to-drainage area relationship

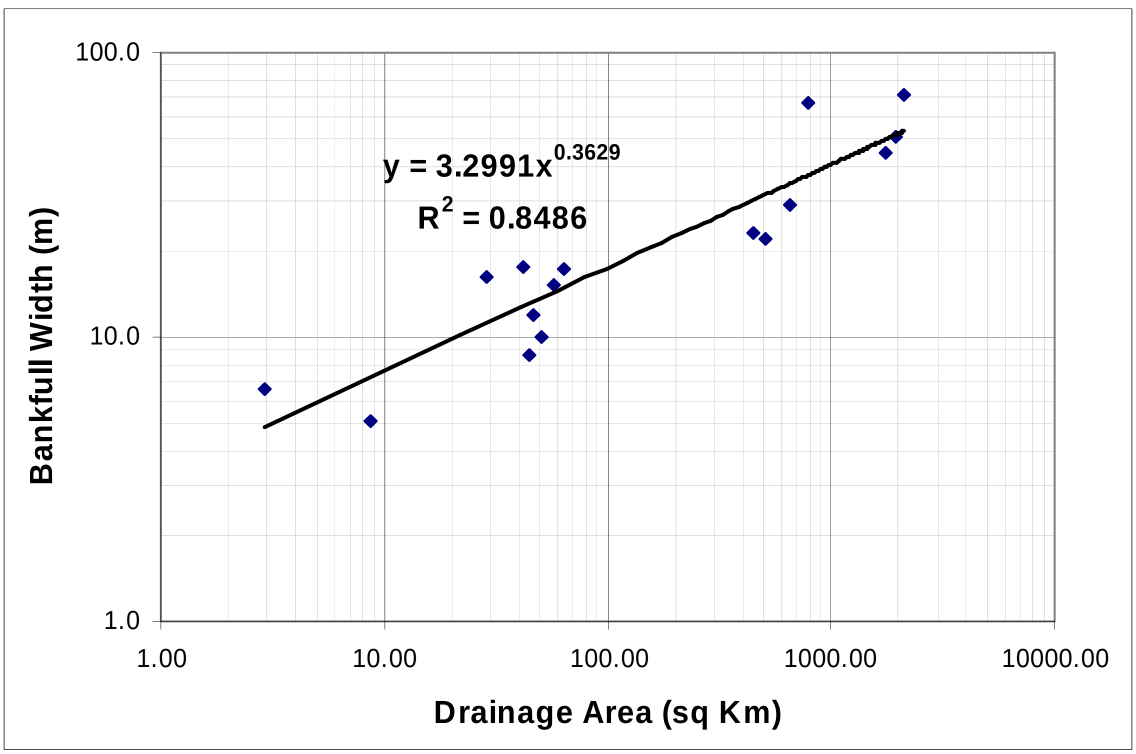

Figure 4.5: Scott River bankfull width-to-drainage area relationship

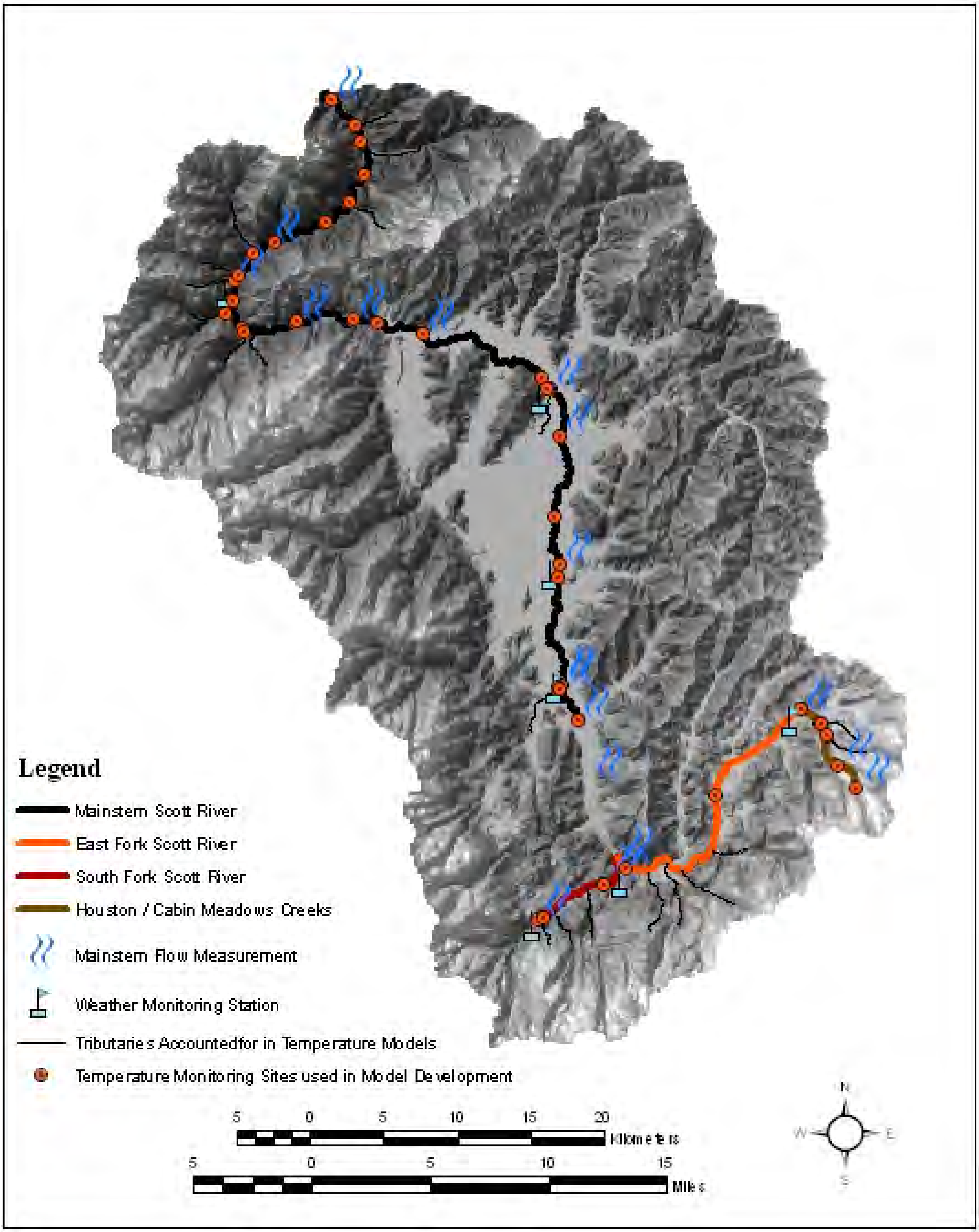

Figure 4.6: Scott River watershed data collection sites and modeled segments

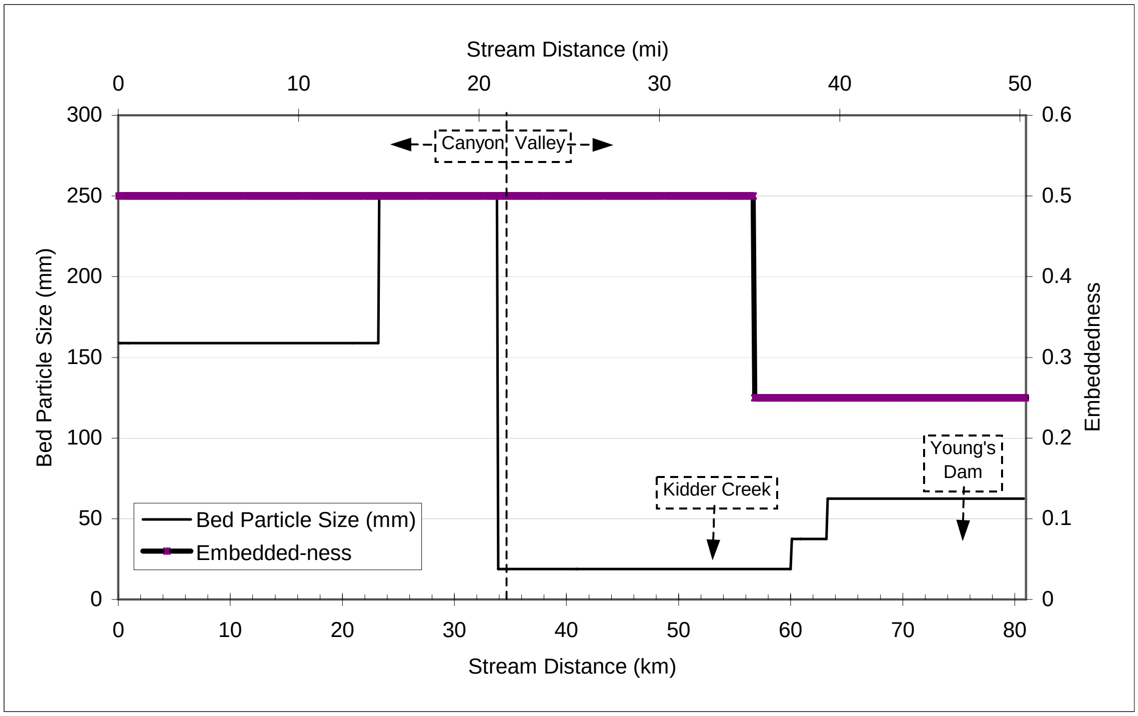

Figure 4.7: Bed particle size and embeddedness, Scott River mainstem

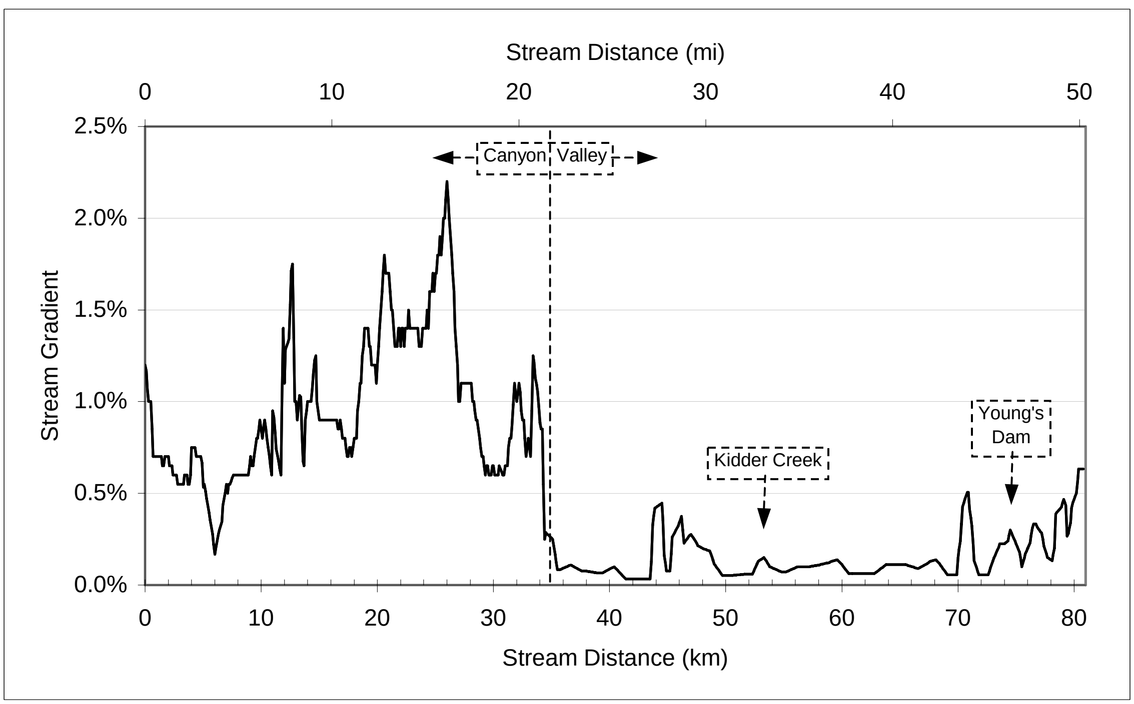

Figure 4.8: Stream gradient, Scott River mainstem

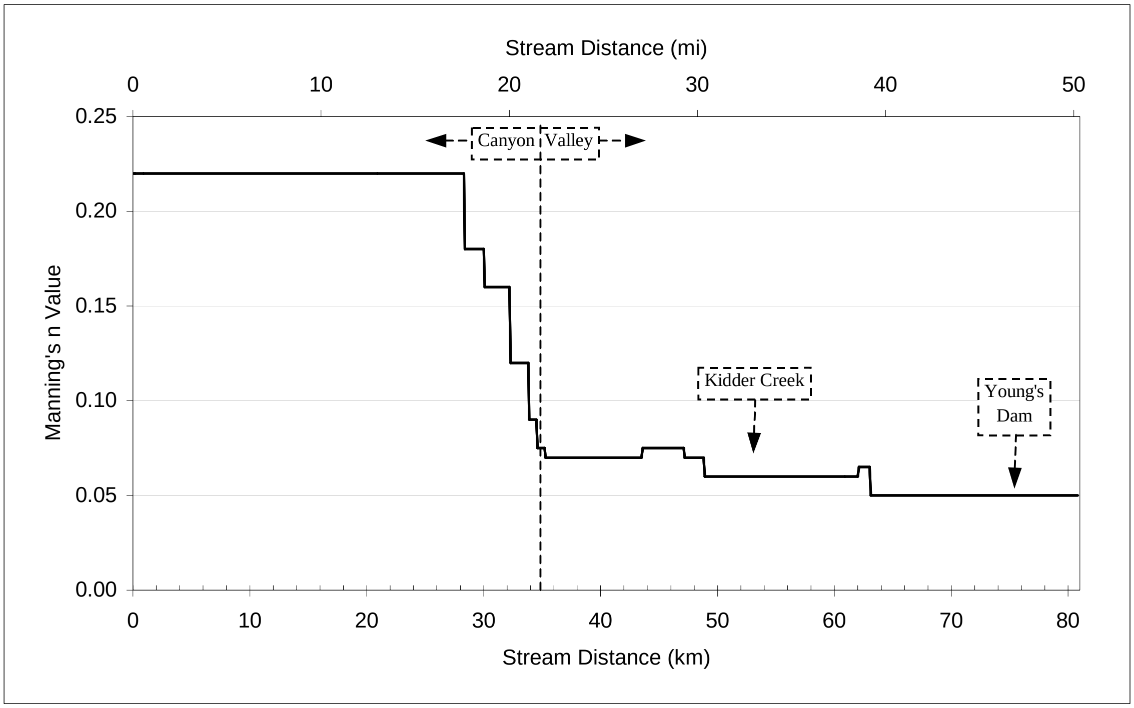

Figure 4.9: Manning's n values, Scott River mainstem

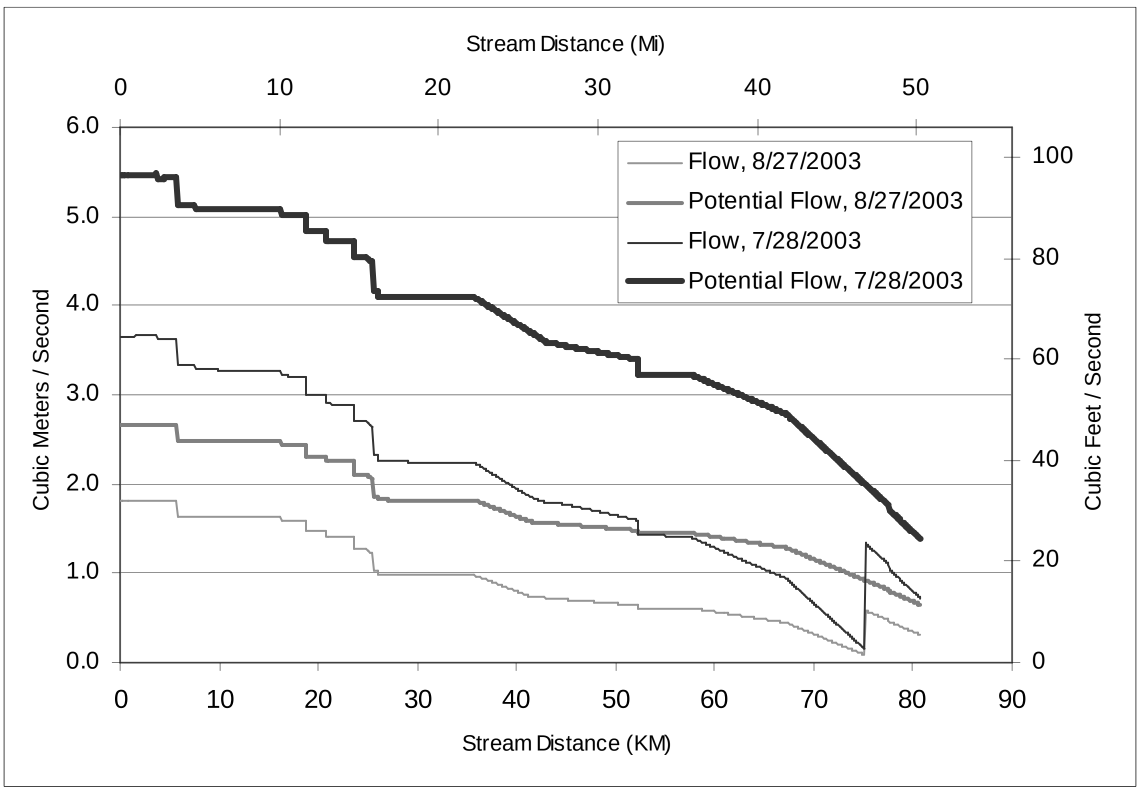

Figure 4.10: Modeled stream flows, Scott River mainstem

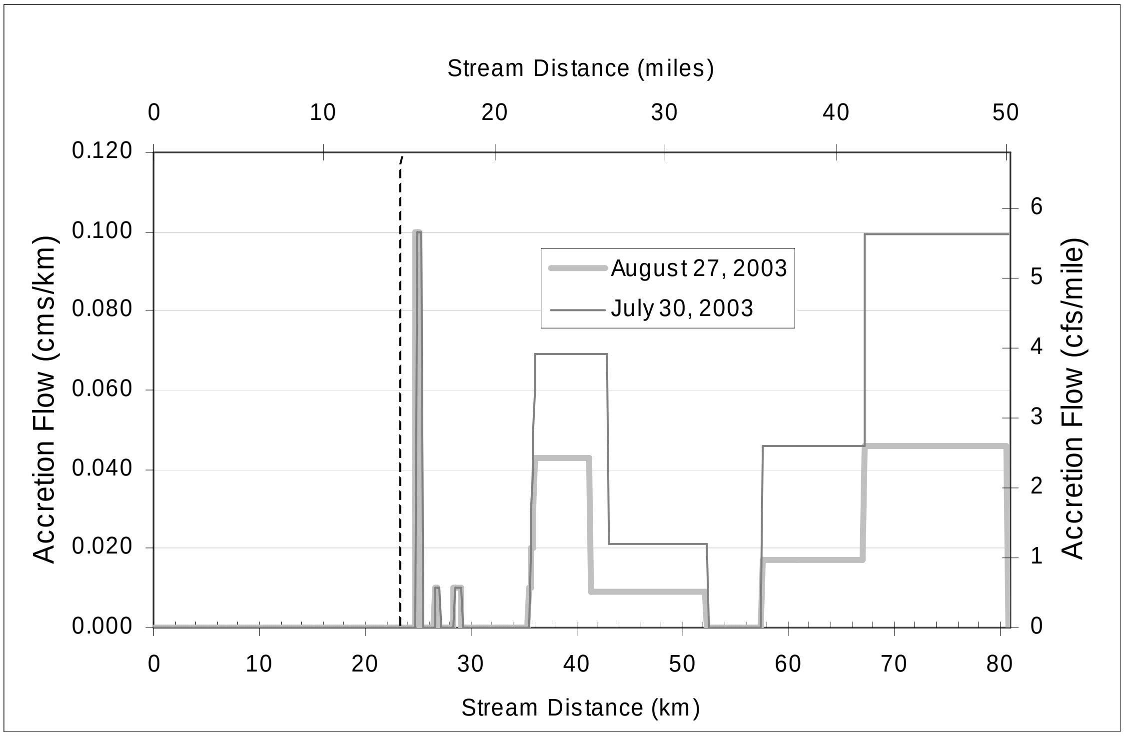

Figure 4.11: Estimated groundwater accretion flows, Scott River mainstem

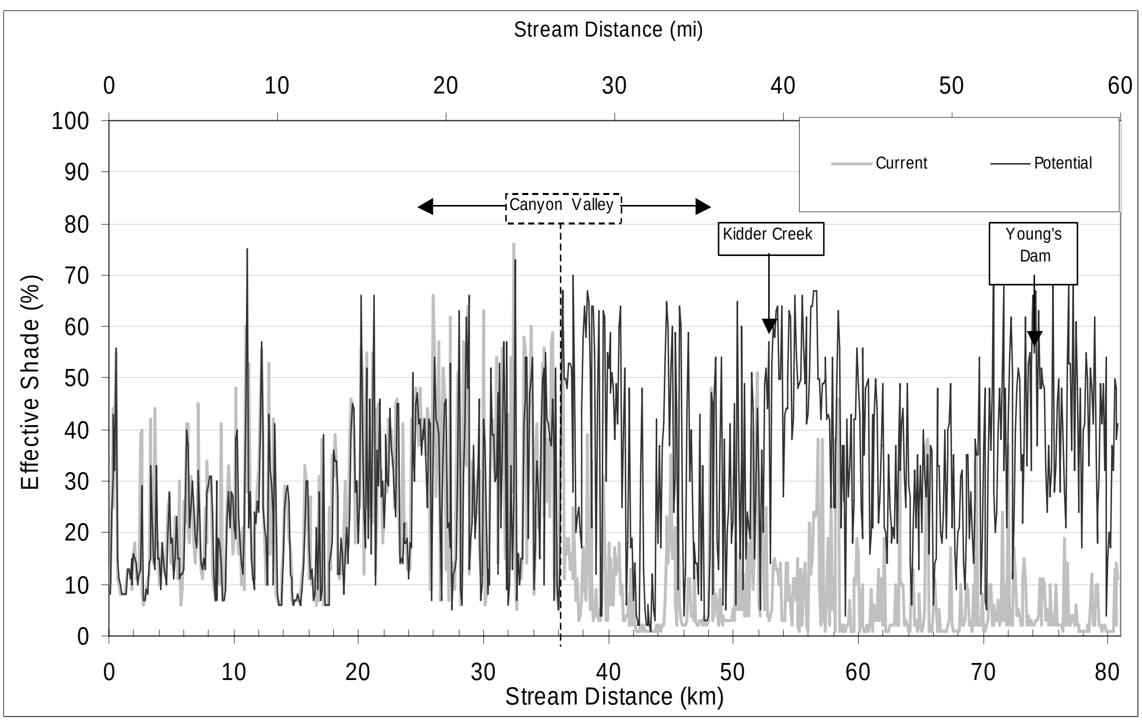

Figure 4.12: Current and potential effective shade, Scott River mainstem, July 30, 2003

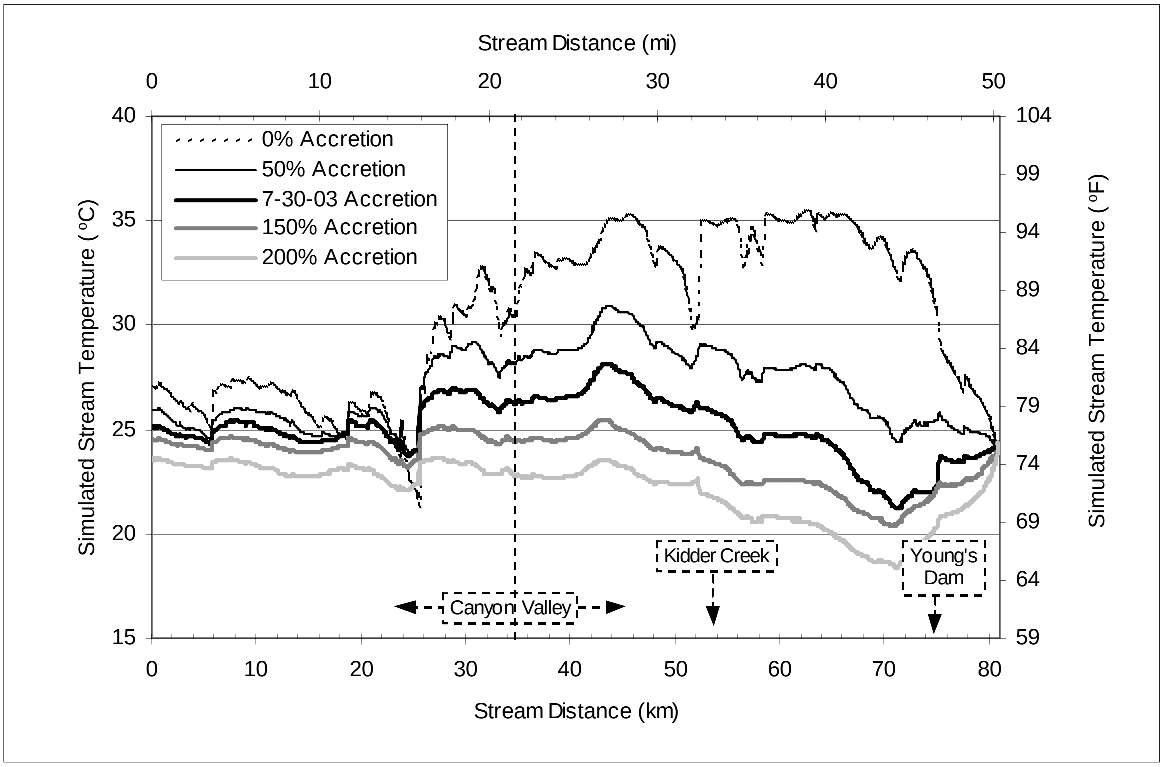

Figure 4.13: Longitudinal profiles of temperature modeling results quantifying effects of groundwater accretion, Scott River mainstem; 3:00 PM, July 30, 2003

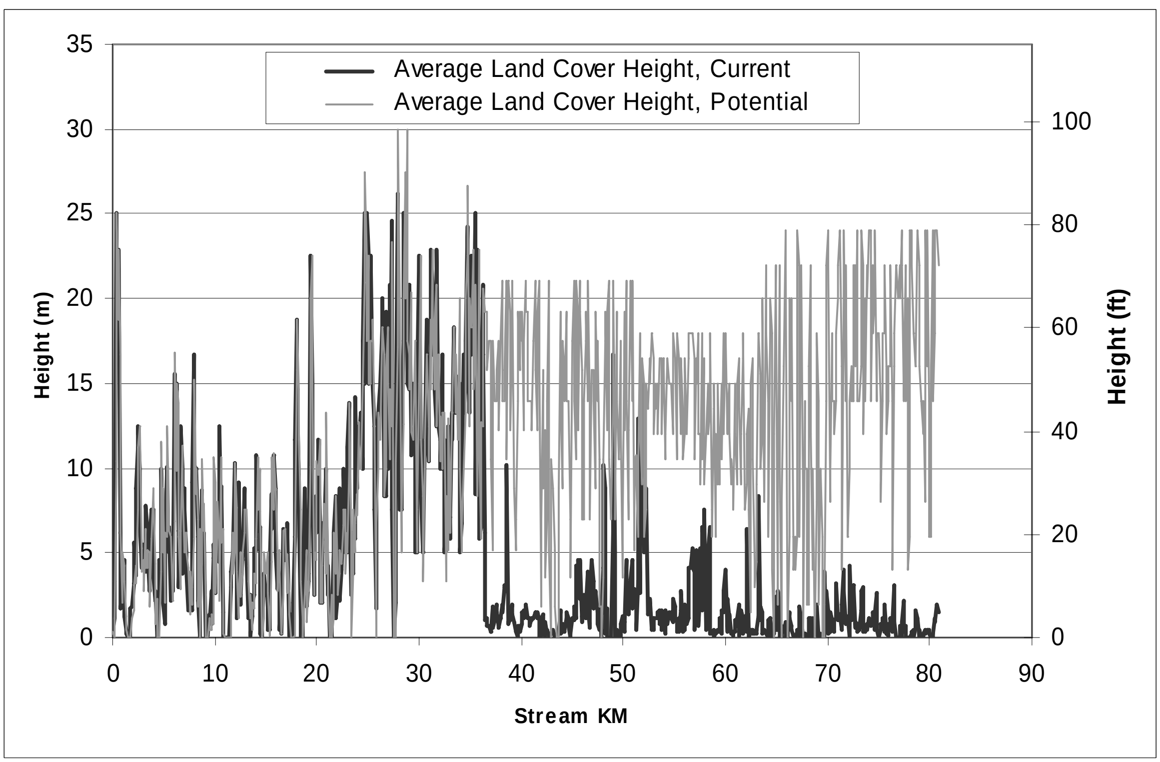

Figure 4.14A: Modeled average land cover heights, left bank, Scott River mainstem

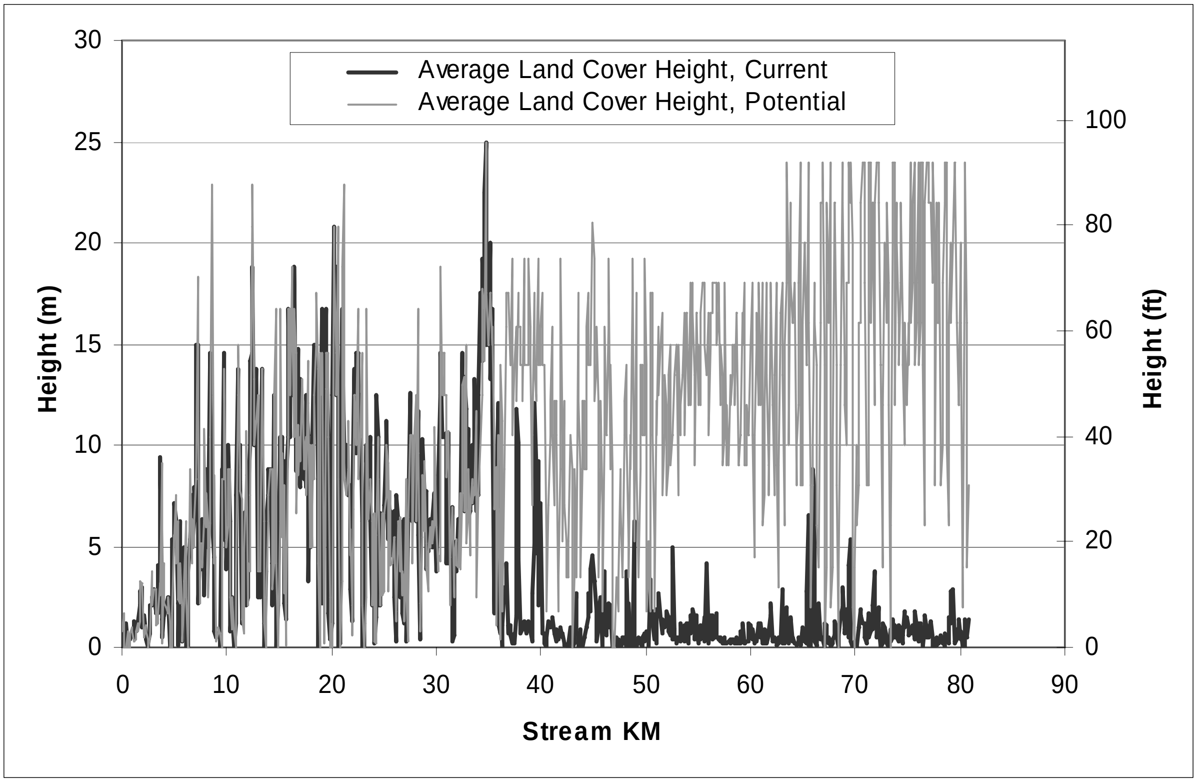

Figure 4.14B: Modeled average land cover heights, right bank, Scott River mainstem

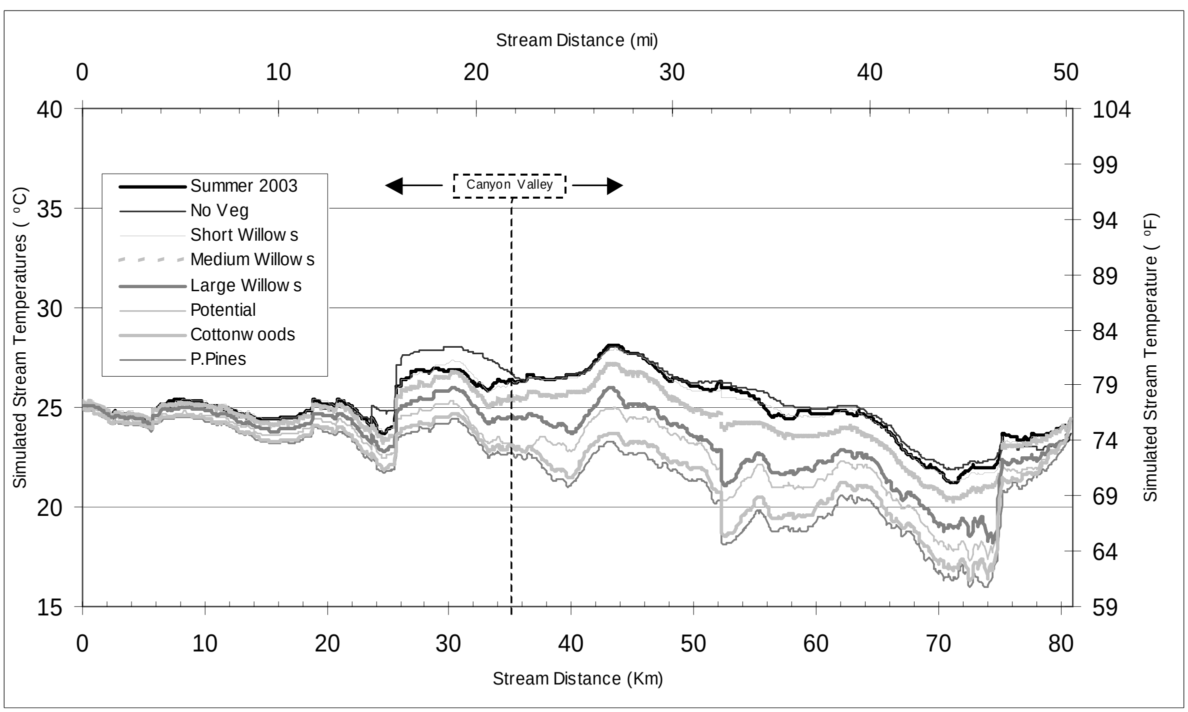

Figure 4.15: Longitudinal profiles of temperature modeling results quantifying effects of riparian vegetation in the Scott River mainstem; 3:00 PM, July 30, 2003

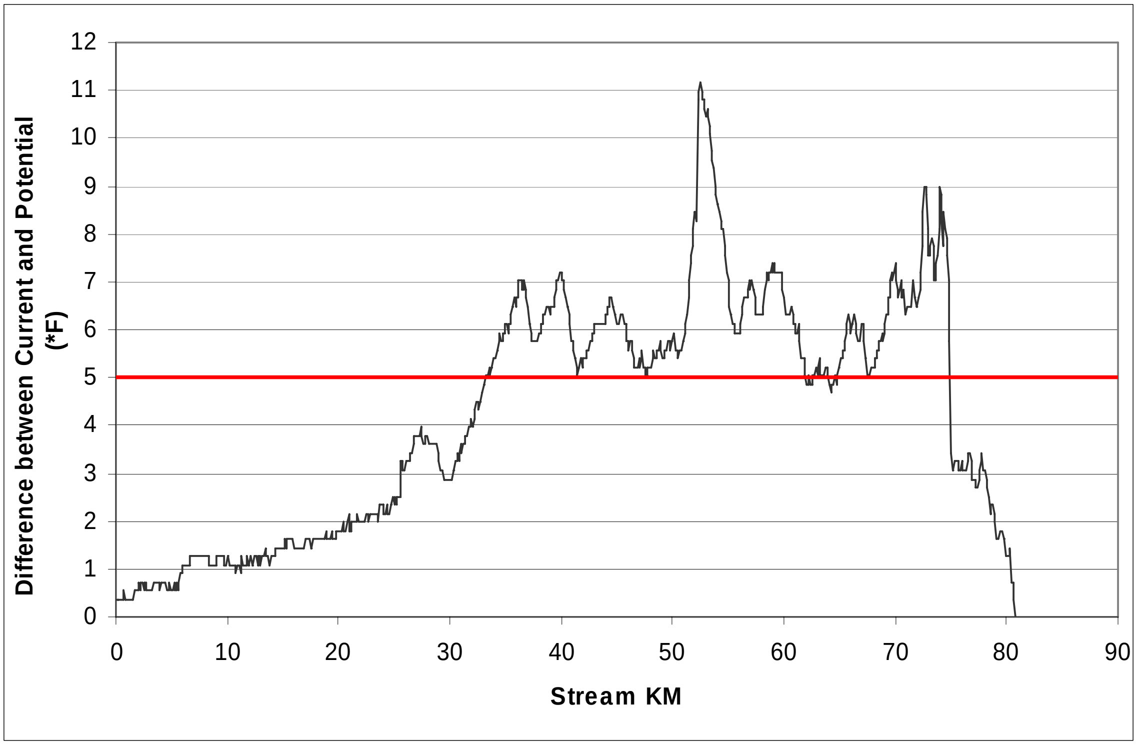

Figure 4.16: Stream temperature differences resulting from current and potential vegetation; Scott River Mainstem; July 31, 2003, 3:00 PM

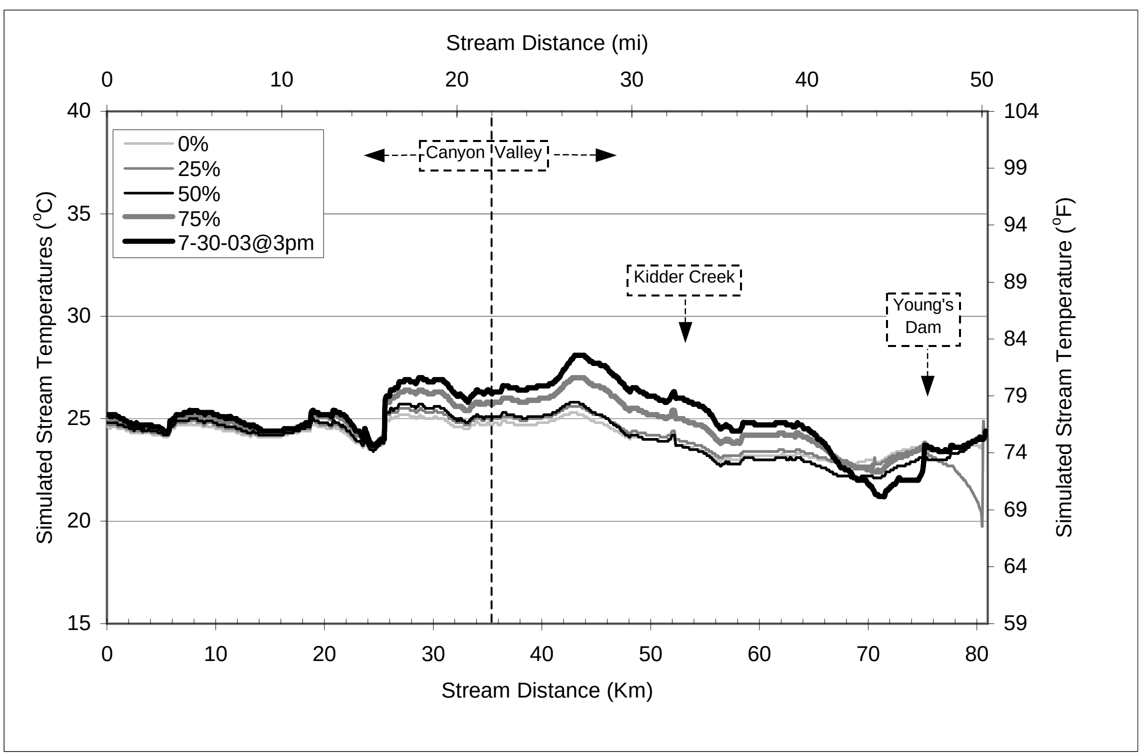

Figure 4.17: Longitudinal profiles of temperature modeling results quantifying effects of changes in surface water diversions in the Scott River Mainstem; 3:00 PM, July 30, 2003

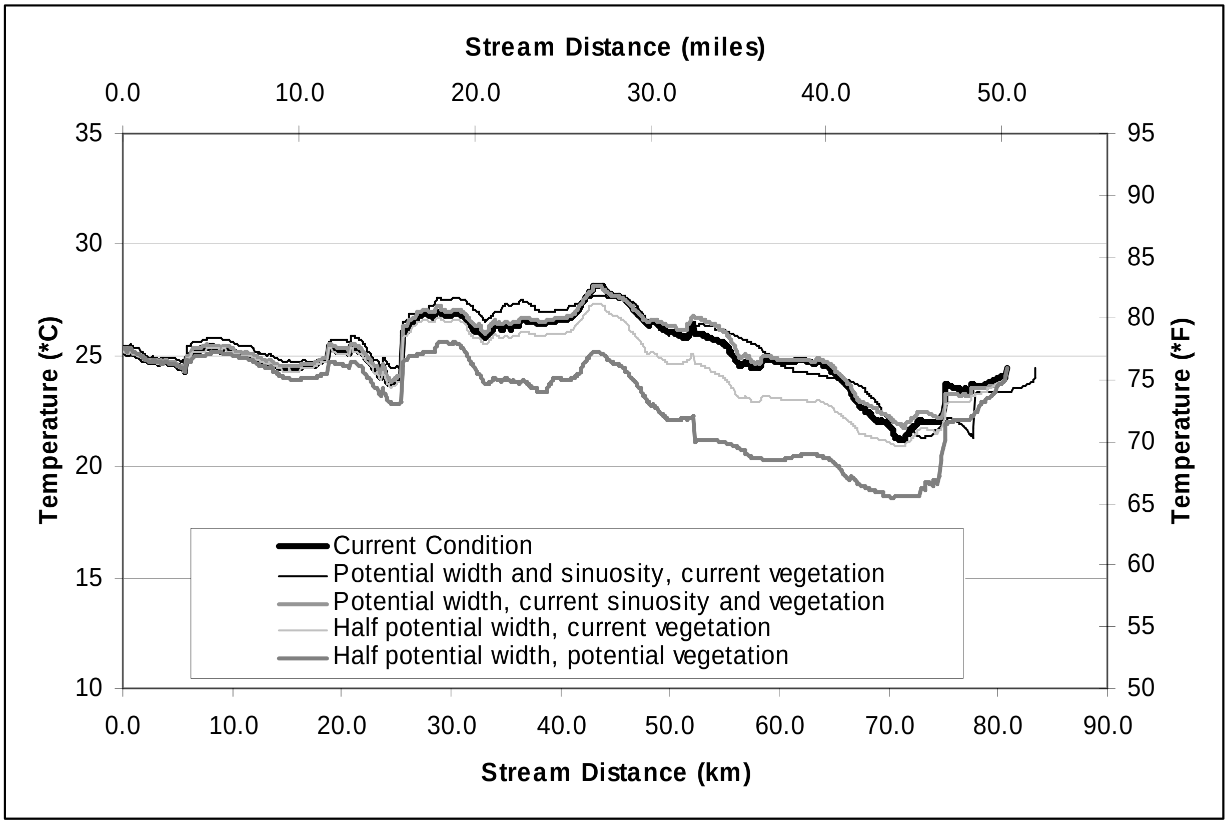

Figure 4.18: Longitudinal profile of temperature modeling results quantifying effects of changes in stream geometry in the Scott River mainstem; 3:00 PM, July 30, 2003

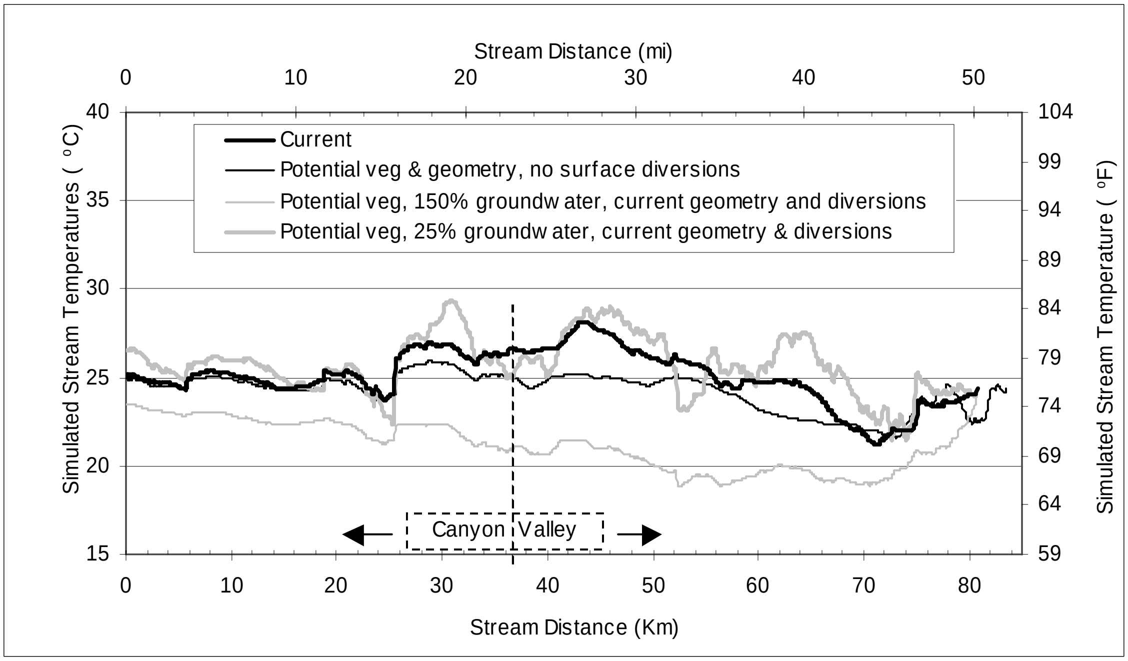

Figure 4.19: Longitudinal profiles of temperature modeling results quantifying effects of combined scenarios, July 30, 2003, Scott River mainstem

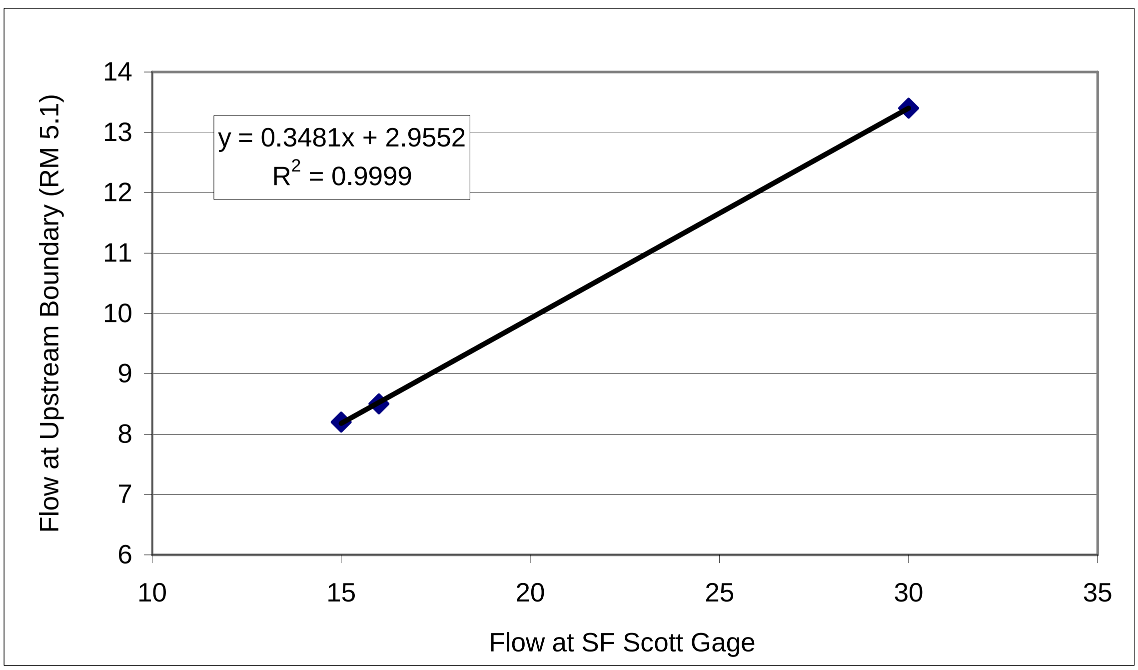

Figure 4.20: Relationship of flow at South Fork Scott River gage to measured flows at the upper model boundary

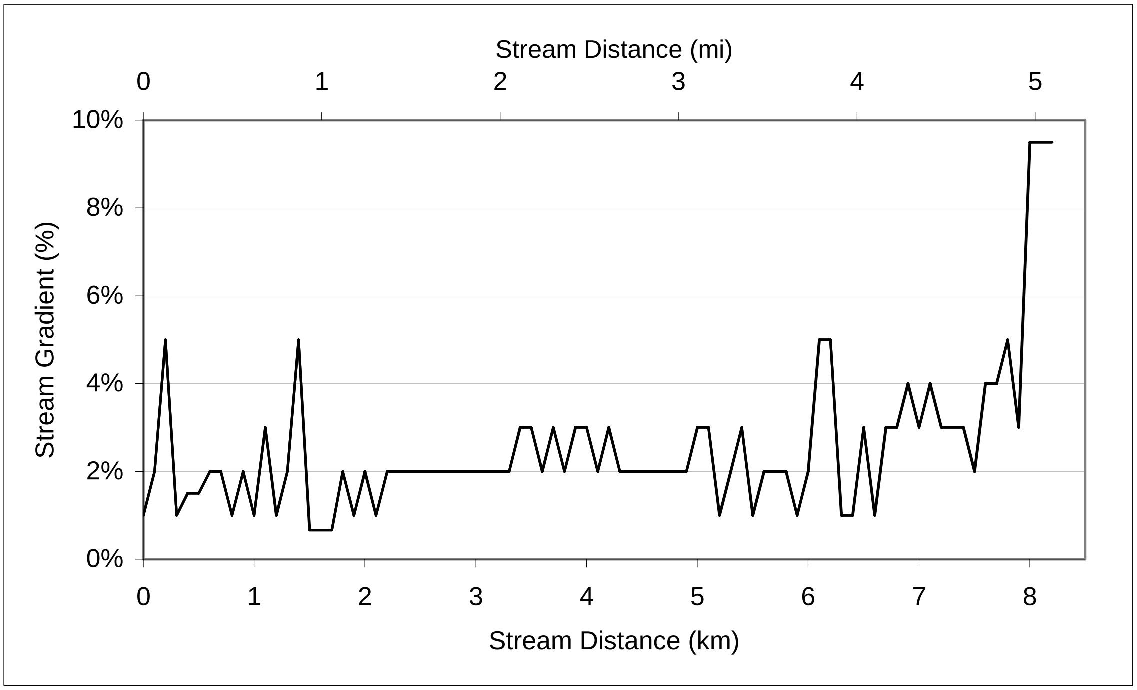

Figure 4.21: Stream gradients, South Fork Scott River

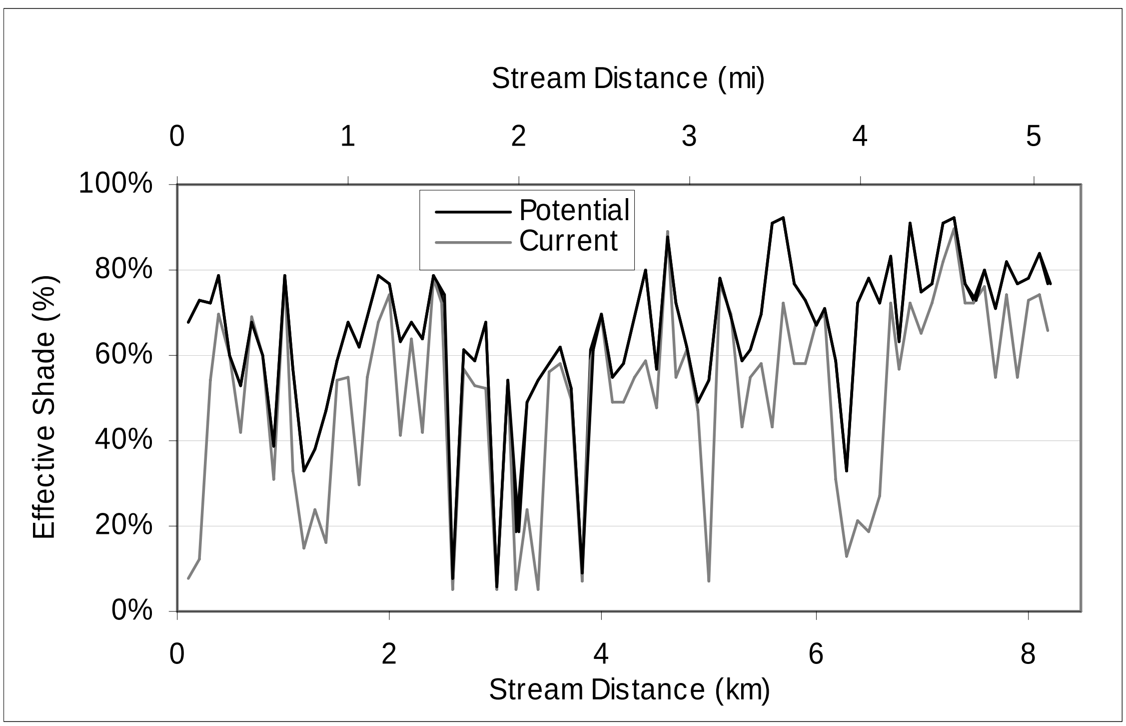

Figure 4.22: Current and potential effective stream shade, South Fork Scott River, July 26, 2003.

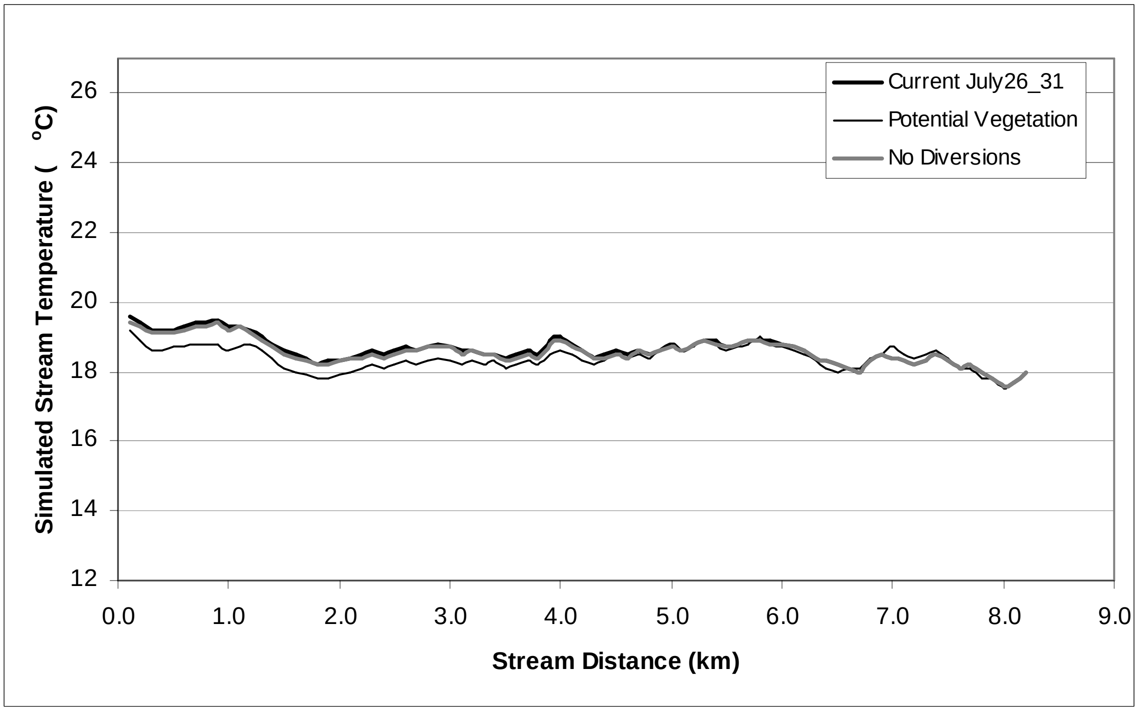

Figure 4.23: Longitudinal profiles of temperature modeling results quantifying effects of vegetation and surface diversions, South Fork Scott River; 3:00 PM, July 26, 2003.

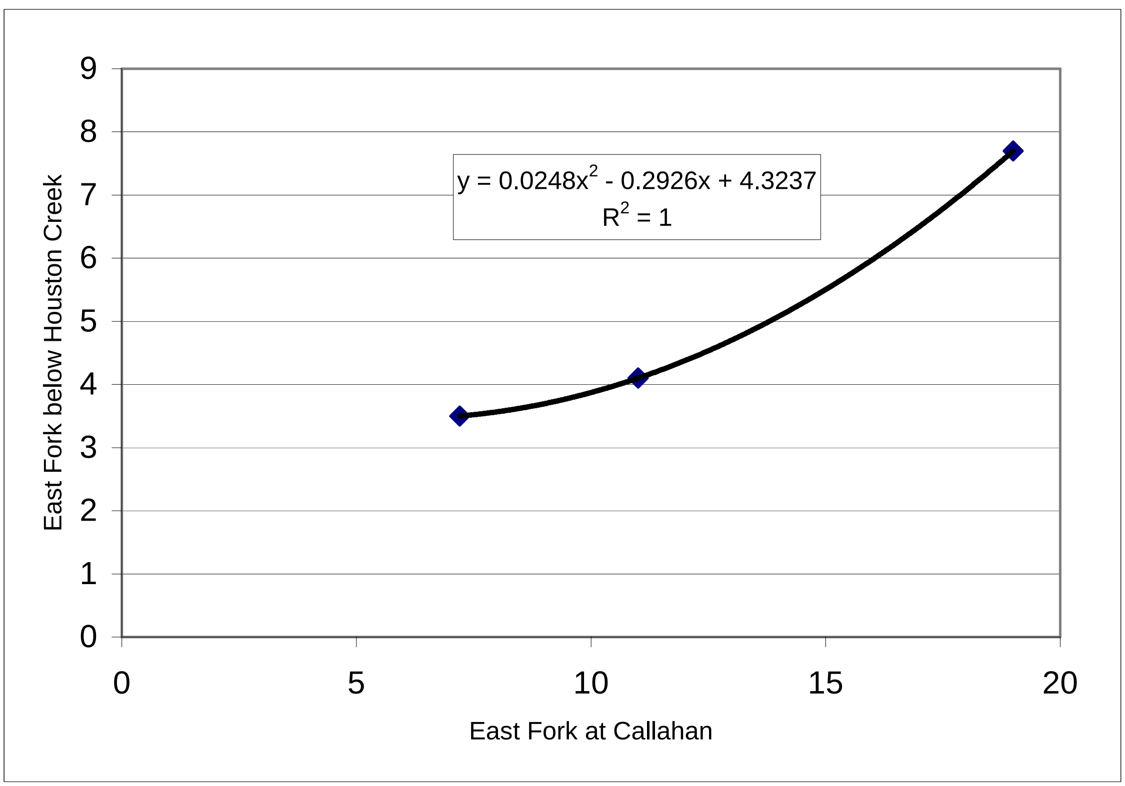

Figure 4.24: Relationship of flows at East Fork Scott River gage to measured flows at the upper model boundary

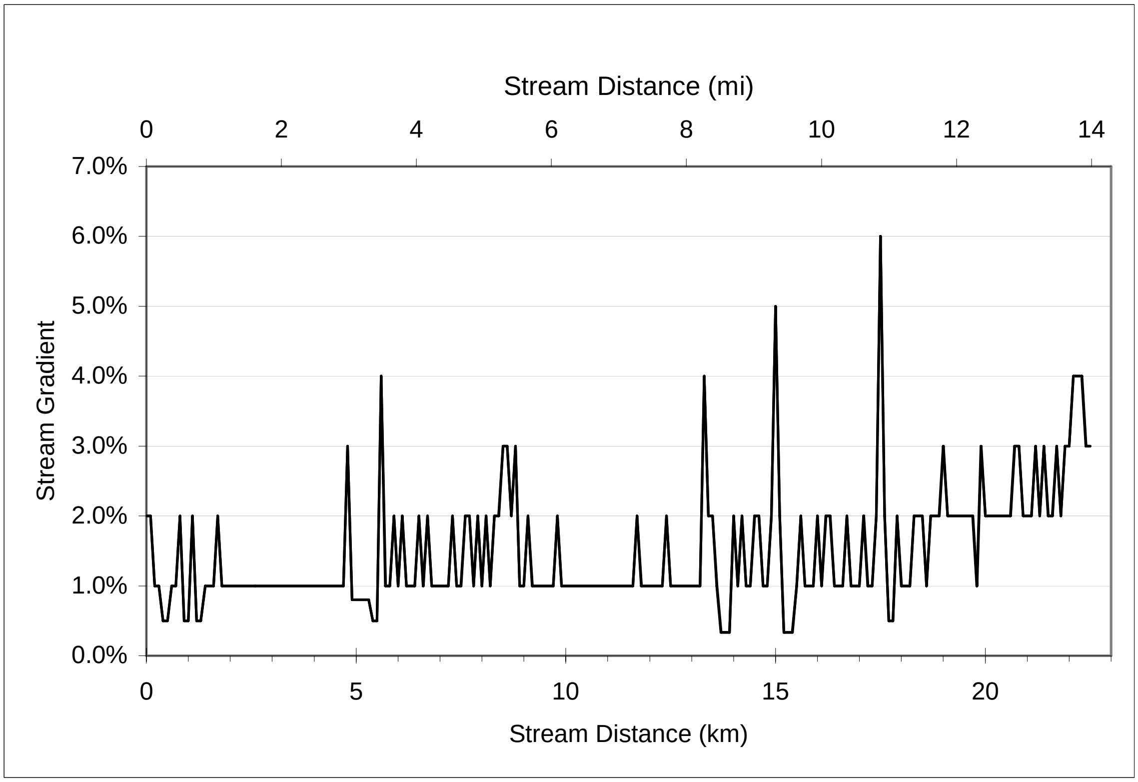

Figure 4.25: Stream gradients, East Fork Scott River

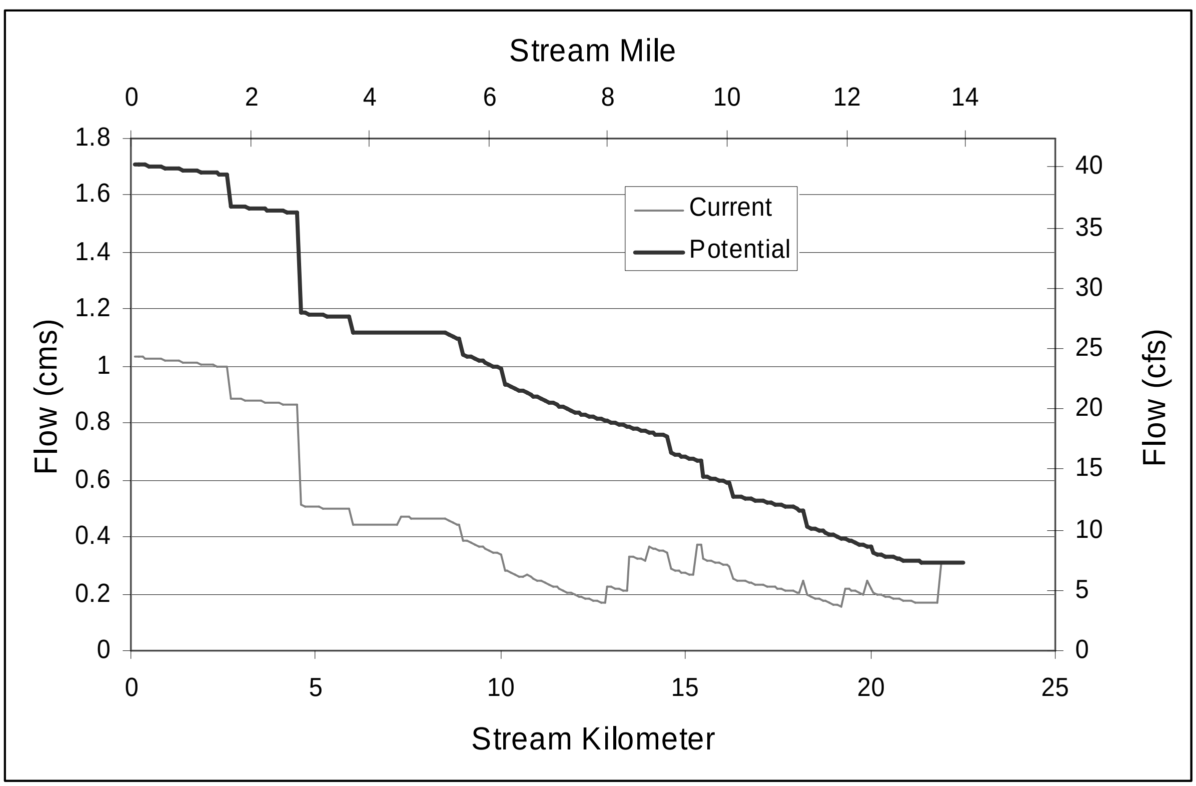

Figure 4.26: Modeled Stream Flows, East Fork Scott River, July 25, 2003

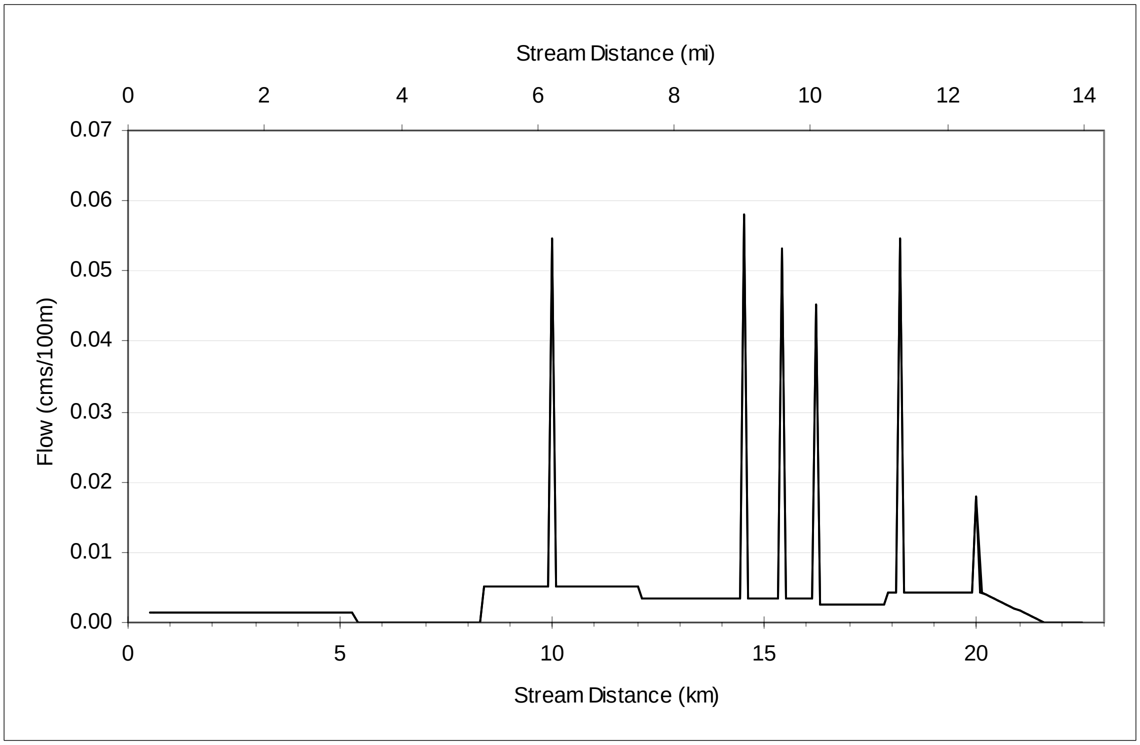

Figure 4.27: Modeled groundwater accretion, East Fork Scott River

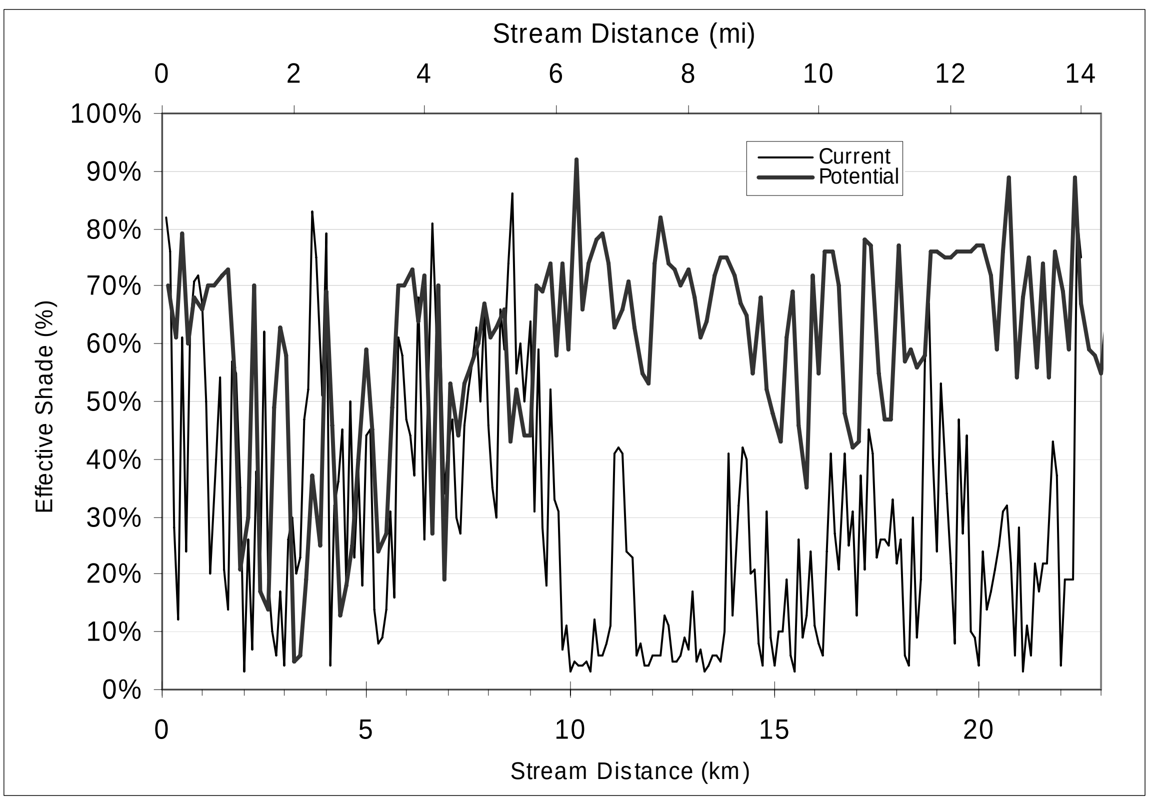

Figure 4.28: Current and potential effective stream shade, East Fork Scott River, July 25, 2003.

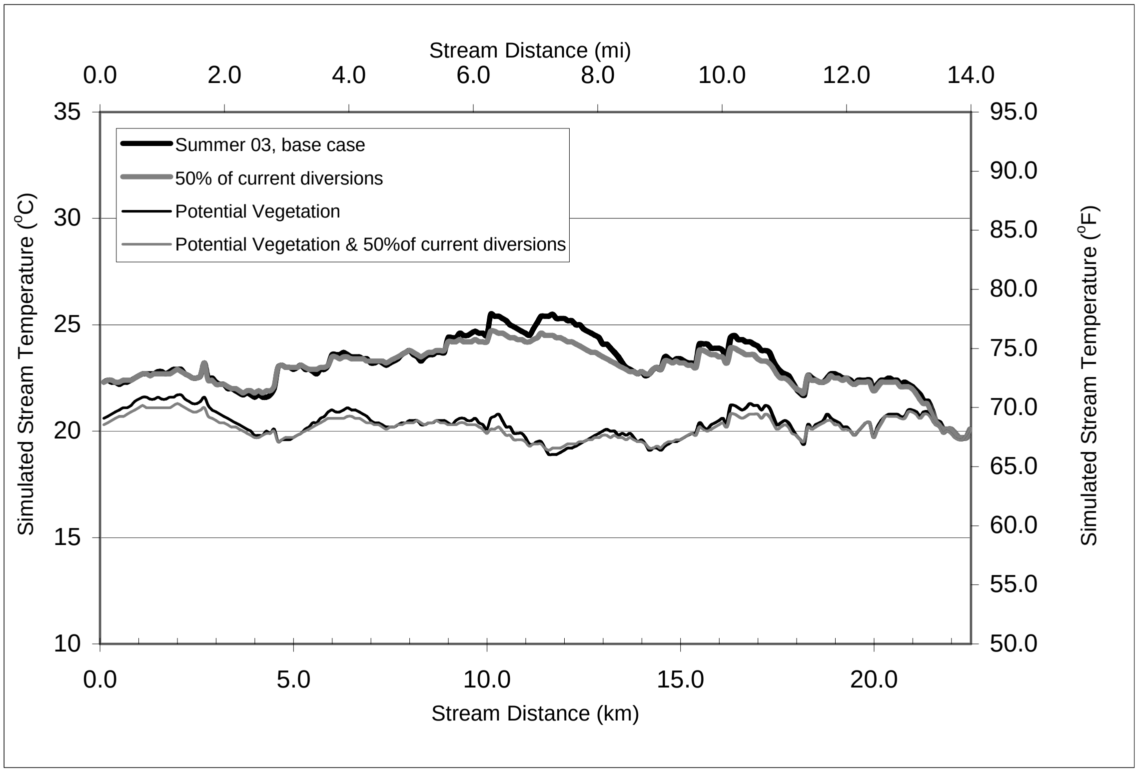

Figure 4.29: Longitudinal profiles of temperature modeling results quantifying effects of vegetation and surface diversions, East Fork Scott River; 3:00 PM, July 25, 2003.

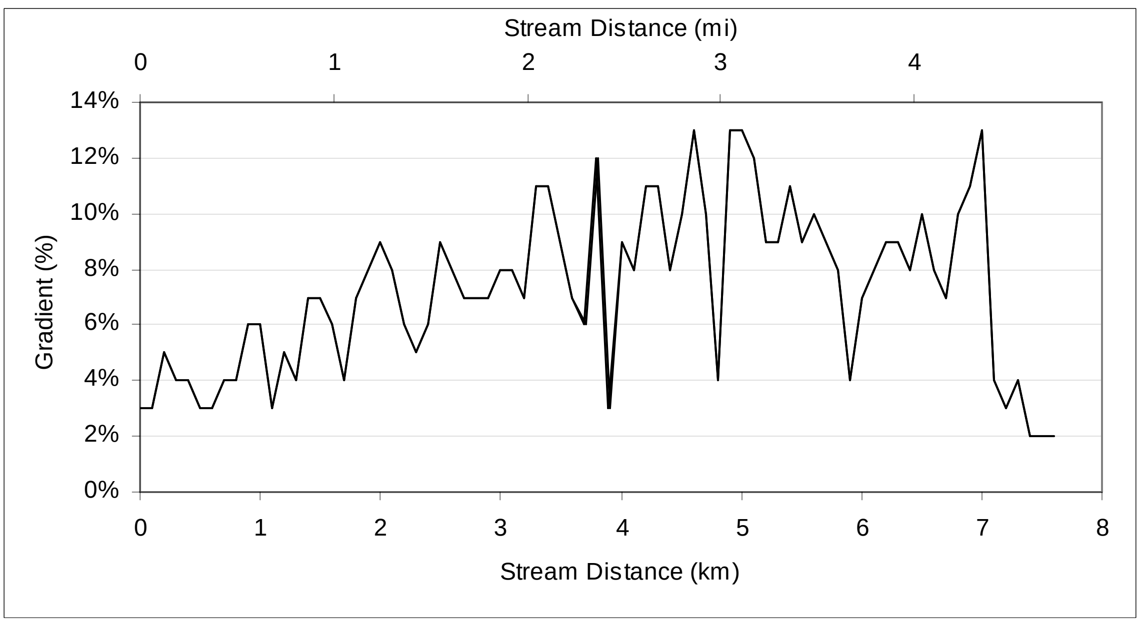

Figure 4.30: Stream gradients, Houston and Cabin Meadows Creeks.

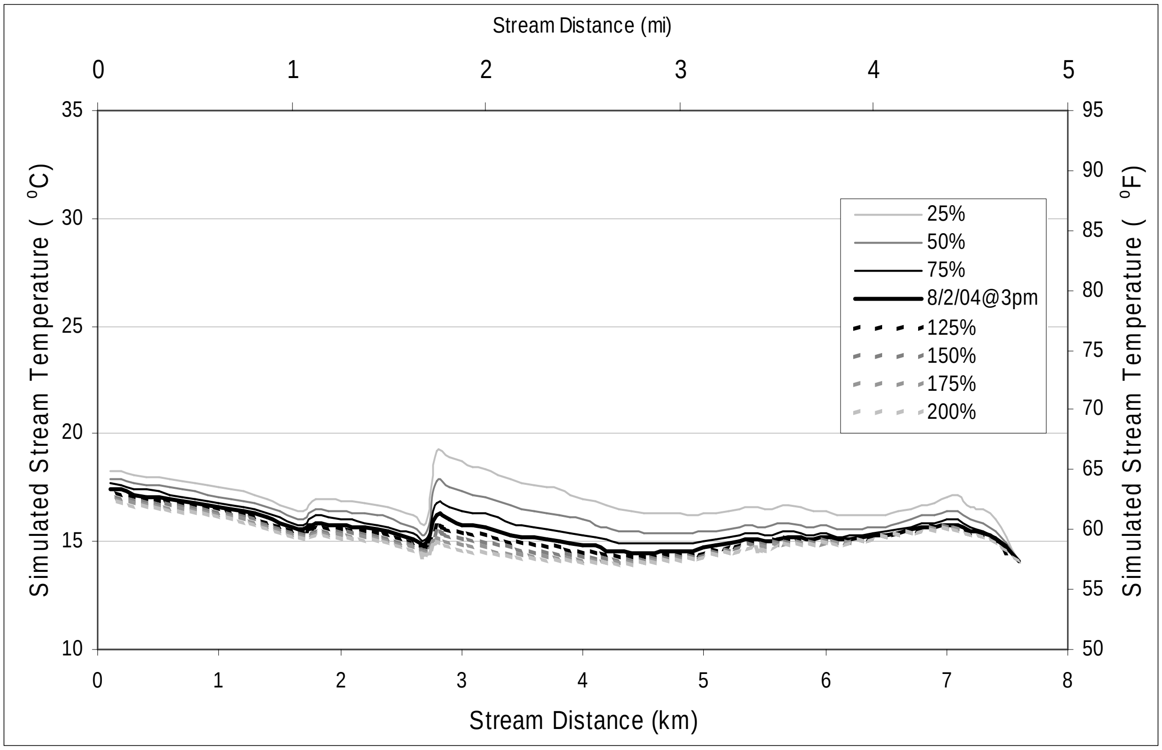

Figure 4.31: Longitudinal profiles of temperature modeling results quantifying effects of changes in surface water flow in Houston and Cabin Meadows Creek; 3:00 PM, August 2, 2004

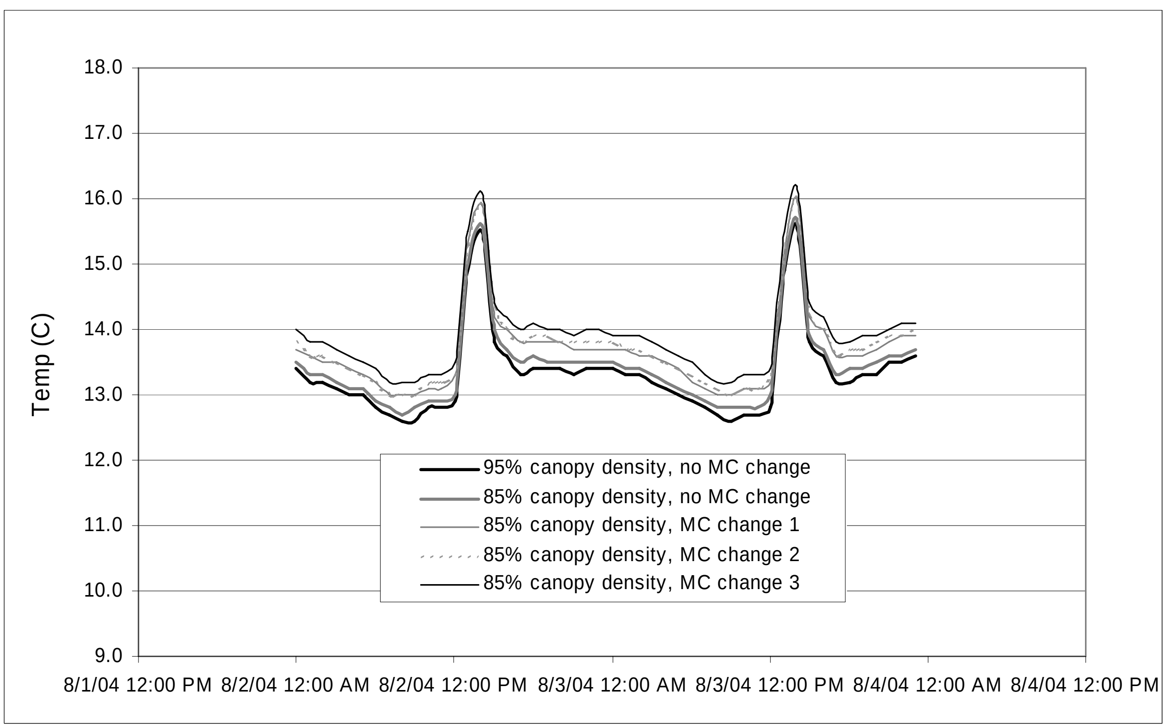

Figure 4.32: Diurnal temperature modeling results quantifying effects of CA Forest Practice Rules' threatened and impaired riparian buffer requirements and potential microclimate effects; 3:00 PM, August 2, 2004.

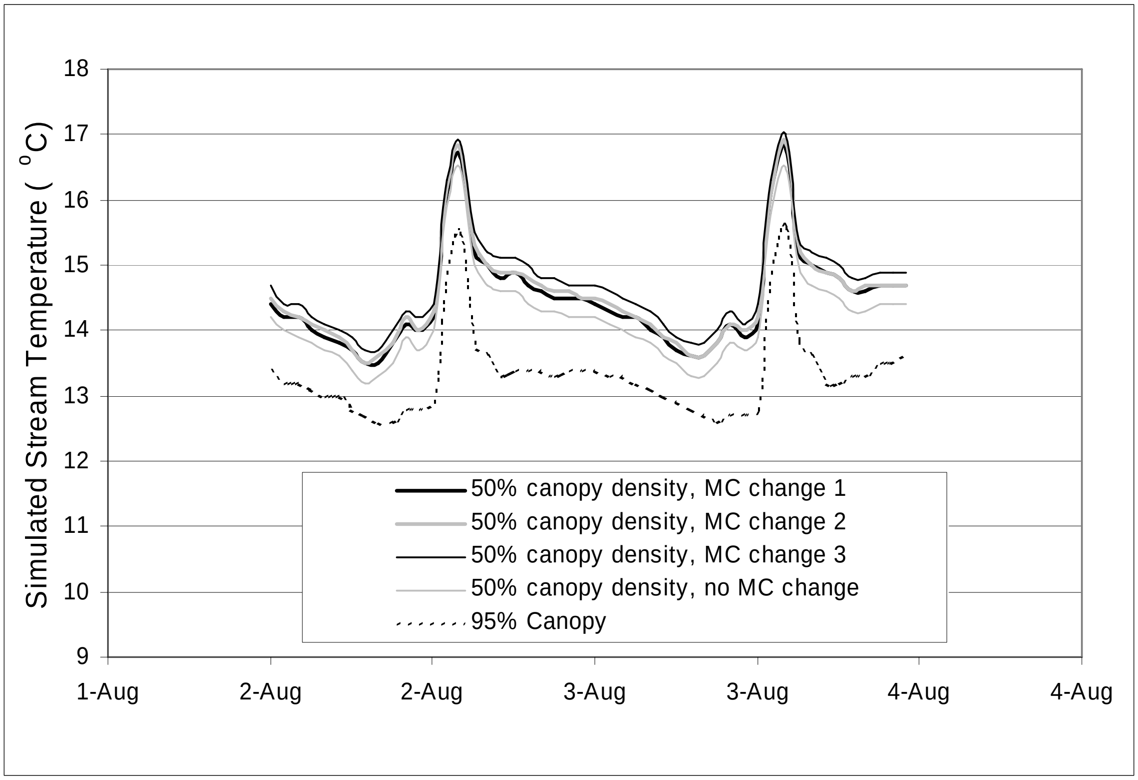

Figure 4.33: Diurnal temperature modeling results quantifying effects of CA Forest Practice Rules' standard riparian buffer requirements and potential microclimate effects; 3:00 PM, August 2, 2004.

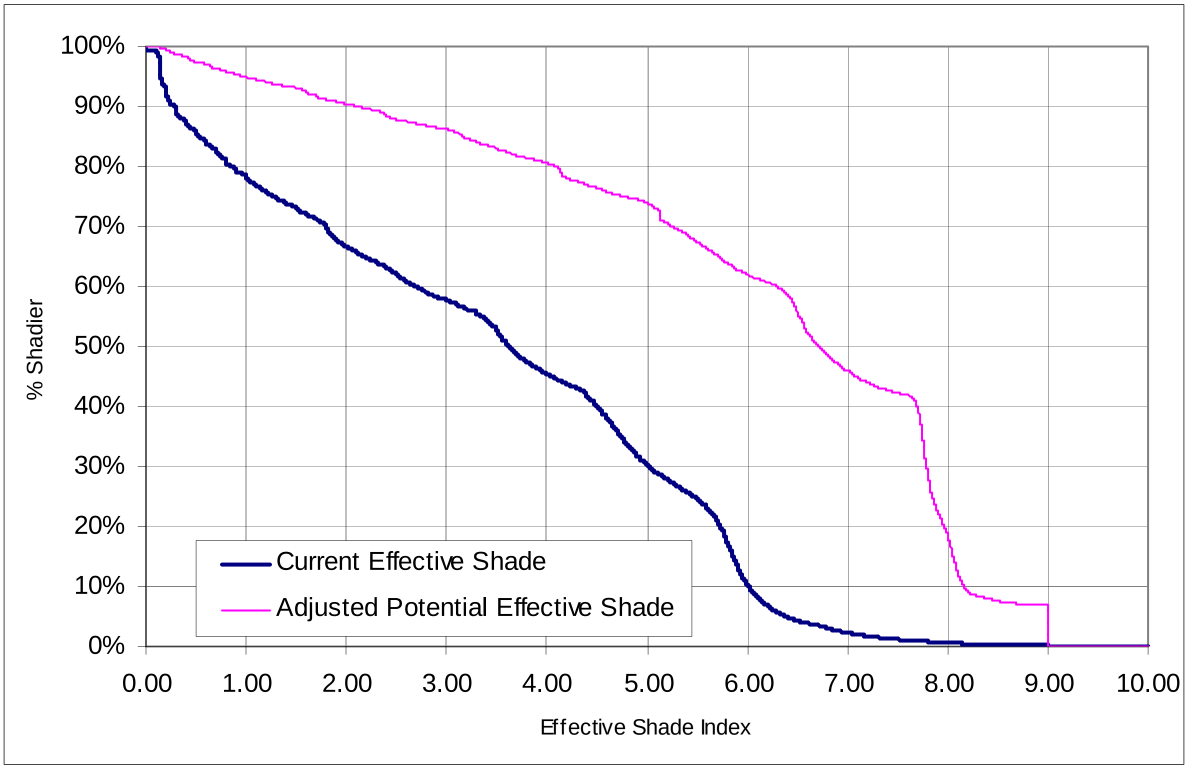

Figure 4.34: Current and desired effective shade exceedence curves, Scott River watershed. ("% Shadier" refers to the percentage of stream length with more shade than the corresponding effective shade index.)

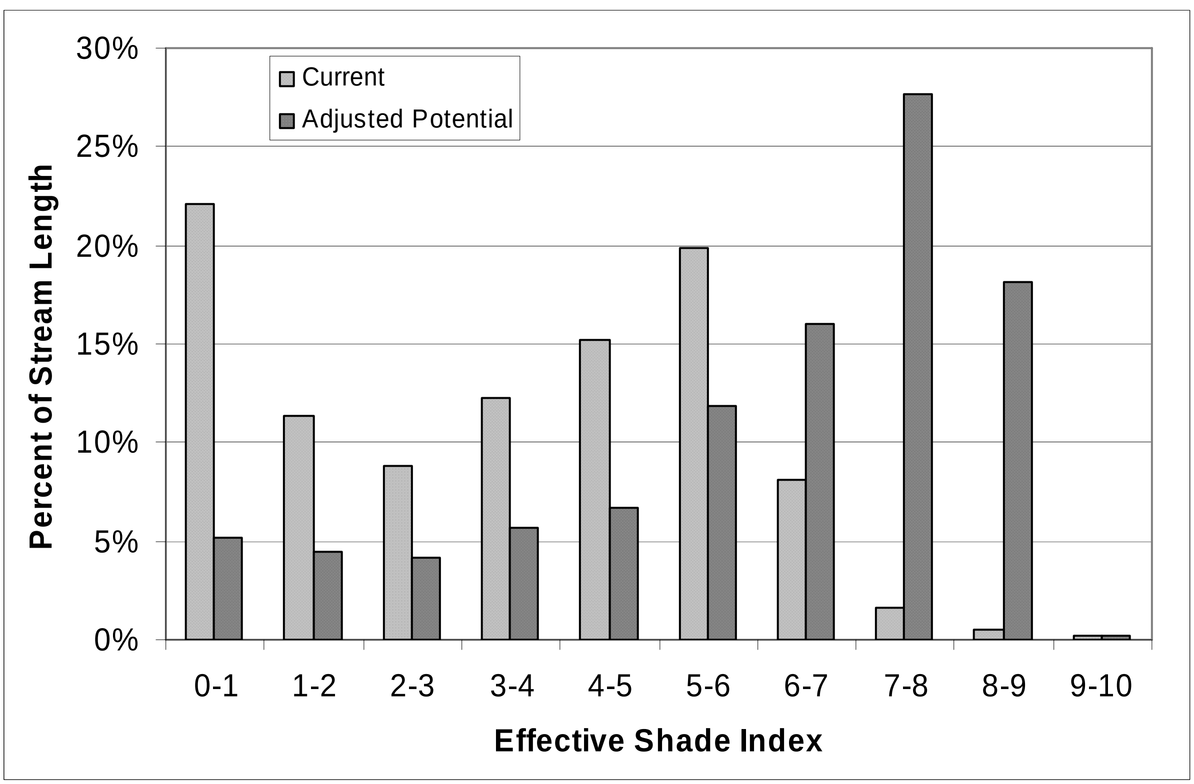

Figure 4.35: Distribution of current and desired effective Shade, Scott River Watershed

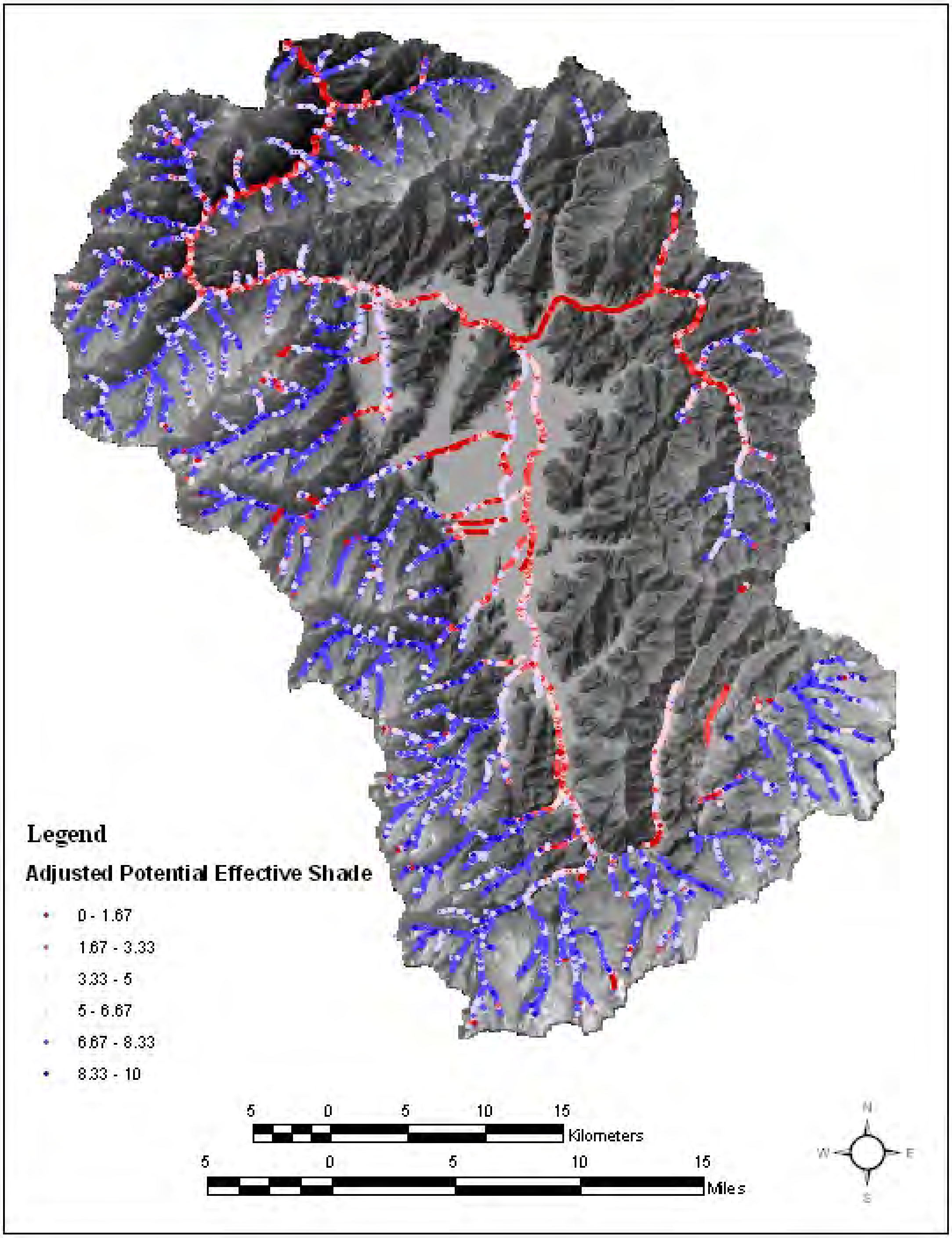

Figure 4.36: Desired effective shade, Scott River watershed

Table 3.1. Areas and stream miles underlain by different geologic units in the Scott River watershed derived from the GIS geology layer of the Geologic Map of California (Saucedo et al., 2000).

Geologic unit	Area (acres)	Area (sq miles)	Area (by percent)	Stream Miles
Quaternary	51218	80	10%	199
Granitic	54938	86	11%	259
Mafic	87370	137	17%	401
Sed & Met	326657	510	63%	1641
TOTALS	***520184***	***813***	***100%***	***2500***

Table 3.2. Areas and stream miles underlain by different geologic units in the seven subwatersheds of the Scott River watershed derived from the GIS geology layer of the Geologic Map of California (Saucedo et al., 2000).

Subwatershed	Geologic Unit	Area (sq miles)	Total Area (sq miles)	Total Area (% watershed)	Geology type (% subwatershed)	Stream Miles	Total subwatershed stream miles
West Canyon	Quaternary	1.3	99	12.1%	1.4%	5	314
	Granitic	7.3			7.4%	26	
	Mafic	24.1			24.4%	78	
	Sed & Met	65.9			66.8%	205	
East Canyon	Quaternary	0.5	100	12.3%	0.5%	4	356
	Granitic	0.0			0.0%	0	
	Mafic	5.0			5.0%	16	
	Sed & Met	94.7			94.5%	336	
Eastside	Quaternary	0.0	121	14.8%	0.0%	0	416
	Granitic	0.0			0.0%	0	
	Mafic	9.6			8.0%	33	
	Sed & Met	110.9			92.0%	383	
East Headwater	Quaternary	4.7	115	14.2%	4.1%	17	362
	Granitic	7.0			6.1%	20	
	Mafic	49.4			42.9%	148	
	Sed & Met	54.1			47.0%	177	
West Headwater	Quaternary	0.8	44	5.4%	1.9%	3	122
	Granitic	21.2			48.3%	59	
	Mafic	16.0			36.4%	41	
	Sed & Met	5.9			13.4%	19	
Westside	Quaternary	7.1	179	22.0%	4.0%	20	528
	Granitic	50.3			28.2%	154	
	Mafic	21.2			11.9%	61	
	Sed & Met	100.0			56.0%	294	
Scott Valley	Quaternary	65.5	156	19.2%	42.1%	150	401
	Granitic	0.0			0.0%	0	
	Mafic	11.2			7.2%	23	
	Sed & Met	79.0			50.7%	227	
TOTALS		***813***	***813***	***100%***		***2500***	***2500***

Table 3.3. Mileage of paved and unpaved roads at different distances from streams in the Scott River watershed (VESTRA developed roads layer)

Geologic Unit	Road proximity to stream network										Road Density			
	Paved Roads (miles)					Unpaved Roads (miles)					(miles / sq. mile)			
	No. of Stream Crossings	Direct Delivery	0 - 100 ft	100 - 200 ft	> 200 ft	No. of Stream Crossings	Direct Delivery	0 - 100 ft	100 - 200 ft	> 200 ft	0 - 100 ft	100 - 200 ft	> 200 ft	Overall
Quaternary	73	3.1	5.8	5.3	90.6	142	6.0	15.2	17.8	147.9	3.1	3.7	3.6	3.5
Granitic	12	0.5	0.7	1.1	3.2	401	16.9	26.1	36.0	178.1	3.7	5.3	2.5	2.9
Mafic	93	3.9	4.3	7.0	27.3	565	23.8	43.0	50.4	281.0	4.8	6.1	2.6	3.0
Sed & Met	181	7.6	11.7	17.8	47.8	2944	124.0	258.7	247.4	1166.6	8.4	8.4	2.7	3.4
TOTALS	***359***	***15***	***23***	***31***	***169***	***4052***	***171***	***343***	***352***	***1774***	***6.5***	***7.0***	***2.8***	***3.3***

Subwatershed	Road proximity to stream network										Road Density			
	Paved Roads (miles)					Unpaved Roads (miles)					(miles / sq. mile)			
	No. of Stream Crossings	Direct Delivery	0 - 100 ft	100 - 200 ft	> 200 ft	No. of Stream Crossings	Direct Delivery	0 - 100 ft	100 - 200 ft	> 200 ft	0 - 100 ft	100 - 200 ft	> 200 ft	Overall
West Canyon	55	2.3	2.6	4.4	10.9	312	13.1	18.2	23.4	182.8	2.6	3.5	2.3	2.5
East Canyon	44	1.9	2.5	5.9	4.7	952	40.1	71.0	73.0	355.9	8.4	9.3	4.3	5.1
Eastside	42	1.8	2.4	2.5	11.6	807	34.0	92.5	68.2	260.8	45.0	34.4	2.3	3.6
East Headwater	67	2.8	4.6	5.3	16.3	473	19.9	40.5	46.4	190.1	5.7	6.7	2.1	2.6
West Headwater	23	1.0	1.3	1.9	9.6	208	8.8	13.0	17.9	99.4	4.4	6.3	2.9	3.3
Westside	51	2.1	3.3	5.5	22.5	937	39.5	70.0	88.8	445.0	5.2	6.9	3.1	3.6
Scott Valley	77	3.2	5.8	5.7	93.3	363	15.3	37.9	34.0	239.6	3.6	3.4	2.5	2.7
TOTALS	***359***	***15***	***23***	***31***	***169***	***4052***	***171***	***343***	***352***	***1774***	***6.5***	***7.0***	***2.8***	***3.3***

Table 3.4. Mileage of paved and unpaved roads at different distances from streams in subwatersheds of the Scott River watershed (VESTRA developed roads layer)

Subwatershed	Geologic unit	Road proximity to stream network										Road Density		
		No. of Stream Crossings	Direct Delivery	0 - 100 ft	100 - 200 ft	> 200 ft	No. of Stream Crossings	Direct Delivery	0 - 100 ft	100 - 200 ft	> 200 ft	0 - 100 ft	100 - 200 ft	> 200 ft
		Paved Roads (miles)					Unpaved Roads (miles)					(miles / sq. mile)		
West Canyon	Quaternary			0.1	0.2	0.3	5	0.2	0.4	0.5	3.0	3.5	4.3	3.2
	Granitic						36	1.5	2.0	2.6	23.2	2.8	3.8	3.9
	Mafic	12	0.5	0.4	1.6	0.8	52	2.2	3.1	4.6	37.2	1.9	3.5	1.9
	Sed & Met	43	1.8	2.0	2.6	9.8	219	9.2	12.6	15.7	119.4	2.7	3.5	2.3
East Canyon	Quaternary	5	0.2	0.4	0.3	0.9	2	0.1	0.3	0.5	0.9	5.8	8.0	6.4
	Granitic													
	Mafic	2	0.1	0.0	0.0	0.1	26	1.1	1.4	1.7	13.8	4.0	4.8	3.3
	Sed & Met	37	1.6	2.0	5.6	3.8	924	38.9	69.3	70.8	341.1	8.6	9.5	4.4
Eastside	Quaternary					0.2						0.0	0.0	10.3
	Granitic													
	Mafic	17	0.7	0.9	1.1	3.5	61	2.6	6.9	5.3	15.4	7.5	6.4	2.5
	Sed & Met	25	1.1	1.6	1.4	7.9	746	31.4	85.5	62.8	245.5	82.6	62.6	2.3
East Headwater	Quaternary						20	0.8	2.0	3.6	10.6	4.3	8.4	2.8
	Granitic						23	1.0	1.5	1.7	10.2	2.5	2.9	1.7
	Mafic	37	1.6	1.9	2.7	9.9	233	9.8	17.1	22.5	110.2	5.8	8.0	2.8
	Sed & Met	30	1.3	2.7	2.6	6.3	197	8.3	19.9	18.6	59.2	6.2	6.1	1.4
West Headwater	Quaternary						11	0.5	0.5	0.8	2.3	6.4	10.5	3.4
	Granitic						83	3.5	5.4	7.5	38.7	3.3	4.9	2.1
	Mafic	15	0.6	0.6	0.8	7.0	85	3.6	4.8	6.5	45.3	5.3	7.4	3.7
	Sed & Met	8	0.3	0.8	1.1	2.6	29	1.2	2.3	3.1	13.1	5.7	8.3	3.2
Westside	Quaternary	6	0.3	0.3	0.5	8.4	31	1.3	2.5	3.2	29.2	4.0	5.6	6.5
	Granitic	12	0.5	0.7	1.1	3.2	259	10.9	17.1	24.2	106.1	4.1	6.0	2.6
	Mafic	9	0.4	0.5	0.6	2.9	94	4.0	8.0	8.1	41.5	5.6	6.0	2.4
	Sed & Met	24	1.0	1.8	3.3	8.0	553	23.3	42.4	53.4	268.3	5.9	7.8	3.2
Scott Valley	Quaternary	62	2.6	5.0	4.4	80.8	73	3.1	9.6	9.2	101.9	2.7	2.8	3.3
	Granitic													
	Mafic	1	0.0	0.0	0.1	3.1	14	0.6	1.7	1.8	17.6	2.3	2.6	2.1
	Sed & Met	14	0.6	0.8	1.3	9.4	276	11.6	26.7	23.0	120.1	4.6	4.1	1.9
TOTALS		***359***	***15***	***23***	***31***	***169***	***4052***	***171***	***343***	***352***	***1774***			

Table 3.5. Rates of road-related sediment contribution in South Fork Scott River watershed, estimated using SEDMODL2 and RM road survey

Rates of road-related sediment contribution in Scott River watershed, estimated through SEDMODL2 and RM road survey.

Geologic Unit	Distance from a stream	Stream Crossing Failures (tons/ xing-yr)	Road-Related Gullies	Fill Failures	Cutbank Failures	Road-Associated Mass Movement	Road Tread Sediment Direct Delivery	Road Tread Sediment Delivery 0 - 100 ft	Road Tread Sediment Delivery 100 - 200 ft	Cut- slope Sediment Direct Delivery	Cut- slope Sediment Delivery 0 - 100 ft	Cut- slope Sediment Delivery 100 - 200 ft
			Road Survey results (tons/mi-yr)				SEDMODL results (tons/mi-yr)					
Quaternary	≤ 200 ft	1.14	0.40	0.95			69.14	5.18	4.24	5.10	0.40	0.33
	> 200 ft		0.01				1.24			0.05		
Mafic	≤ 200 ft	1.06	3.28	0.10	0.03	2.84	18.36	1.61	0.94	1.71	0.16	0.10
	> 200 ft	0.00	0.14				0.53			0.03		
Sed & Met	≤ 200 ft	0.57	0.20	0.48			9.08	0.78	0.51	0.93	0.09	0.06
	> 200 ft	0.00	0.00				0.73			0.05		
Granitic	≤ 200 ft	0.11	2.66	0.43	0.05		57.22	5.49	2.96	18.83	2.01	1.08
	> 200 ft	0.00	0.17				2.52			0.60		

Rates of road-related granitic sediment contribution in Scott River watershed, estimated through GSS

Geologic Unit		Fill-slope Sediment Direct Delivery	Fill-slope Sediment Delivery 0 - 100 ft	Fill-slope Sediment Delivery 100 - 200 ft	Road Tread Sediment Direct Delivery	Road Tread Sediment Delivery 0 - 100 ft	Road Tread Sediment Delivery 100 - 200 ft	Cut-slope Sediment Direct Delivery	Cut-slope Sediment Delivery 0 - 100 ft	Cut-slope Sediment Delivery 100 - 200 ft
		Granitic Sediment Study (Sommarstrom et. al., 1990) (tons/mi-yr)								
Granitic		3.85	1.35	0.38	37.01	12.95	3.70	98.87	34.61	9.89

Table 3.6. Rates of road-related sediment contribution in Scott River watershed estimated by extrapolation of rates estimated in South Fork watershed (West Headwater subwatershed) (Table 3.5).

Rates of road-related sediment contribution in Scott River watershed, estimated through SEDMODL2 and RM road survey.

Geologic Unit	Distance from a stream	Stream Crossing Failures	Road-Related Gullies	Fill Failures	Cutbank Failures	Road-Associated Mass Movement	Road Tread Sediment Direct Delivery	Road Tread Sediment Delivery 0 - 100 ft	Road Tread Sediment Delivery 100 - 200 ft	Cut-slope Sediment Direct Delivery	Cut-slope Sediment Delivery 0 - 100 ft	Cut-slope Sediment Delivery 100 - 200 ft	Total Sediment Delivery (tons/yr)	Total Sediment Delivery (tons/ sq mi-yr)
		Road Survey results (tons/yr)					SEDMODL results (tons/yr)							
Quaternary	≤ 200 ft	244	21	51			414	79	76	46	9	8	**947**	12
	> 200 ft		2										**2**	
Mafic	≤ 200 ft	694	434	13	4	376	437	69	47	47	8	6	**2137**	16
	> 200 ft		44										**44**	
Sed & Met	≤ 200 ft	1775	134	317			1126	202	125	122	24	15	**3840**	8
	> 200 ft		4										**4**	
Granitic	≤ 200 ft	44	216	35	4		967	143	106	328	54	40	**1936**	***23***
	> 200 ft		31										**31**	

Rates of road-related granitic sediment contribution in Scott River watershed, determined through GSS

Geologic Unit	Fill-slope Sediment Direct Delivery	Fill-slope Sediment Delivery 0 - 100 ft	Fill-slope Sediment Delivery 100 - 200 ft	Road Tread Sediment Direct Delivery	Road Tread Sediment Delivery 0 - 100 ft	Road Tread Sediment Delivery 100 - 200 ft	Cut-slope Sediment Direct Delivery	Cut-slope Sediment Delivery 0 - 100 ft	Cut-slope Sediment Delivery 100 - 200 ft	Total Sediment Delivery (tons/yr)	Total Sediment Delivery (tons/ sq mi-yr)
	Granitic Sediment Study (Sommarstrom et. al.) (tons/year)										
Granitic	67	36	14	625	337	133	1720	927	367	**4227**	***49***

Watershed Totals (tons/yr) (SEDMODL2 & RM road survey delivery rates for all geologic units)	***2757***	***886***	***416***	***8***	***376***	***2943***	***493***	***355***	***544***	***94***	***69***	***8940***	***11***
Watershed Totals (tons/yr) (substituting Granitic Sediment Study delivery rates for granitic geologic unit)	***2714***	***639***	***498***	***4***	***376***	***2601***	***687***	***381***	***1936***	***967***	***396***	***11200***	***14***

Table 3.7. Road-related sediment contribution in Scott River watershed estimated by extrapolation of rates estimated in South Fork watershed (West Headwater subwatershed)(Table 3.5). (Tons/yr)

Road-related non-granitic sediment contribution in Scott River watershed derived from SEDMODL2 & RM road survey.		Stream Crossing Failures	Road-Related Gullies	Fill Failures	Cutbank Failures	Road Related Mass Movement	Road Tread Sediment Delivery	Cut-slope Sediment Delivery	Total Delivery / Geol. unit
West Canyon	Quaternary	5.7	0.6	1.4			18.8	1.5	**28**
	Mafic	67.5	46.3	1.2	0.4	35.4	49.5	5.8	**206**
	Sed & Met	148.8	9.2	20.9			101.5	12.6	**293**
East Canyon	Quaternary	8.0	0.7	1.7			9.5	2.1	**22**
	Mafic	29.5	16.2	0.4	0.1	9.2	24.0	2.4	**82**
	Sed & Met	545.8	38.9	89.5			443.2	48.4	**1166**
Eastside	Quaternary		0.0						**0**
	Mafic	82.3	60.3	1.7	0.6	50.0	63.4	7.5	**266**
	Sed & Met	437.9	37.7	87.4			383.7	41.6	**988**
East Headwater	Quaternary	22.7	2.7	6.1			83.9	6.3	**122**
	Mafic	284.9	199.1	5.5	1.8	157.9	228.9	25.0	**903**
	Sed & Met	128.9	10.9	25.4			100.3	12.1	**278**
West Headwater	Quaternary	12.5	0.7	1.7			35.3	2.8	**53**
	Mafic	105.5	62.8	1.7	0.6	48.1	79.5	8.8	**307**
	Sed & Met	21.0	1.9	4.2			14.4	2.0	**43**
Westside	Quaternary	42.0	3.4	7.6			116.6	10.3	**180**
	Mafic	108.7	76.6	2.1	0.7	61.0	93.1	9.6	**352**
	Sed & Met	327.7	26.0	59.5			271.5	29.8	**715**
Scott Valley	Quaternary	153.4	14.8	32.2			301.4	39.4	**541**
	Mafic	15.8	16.6	0.4	0.1	11.9	15.2	1.5	**62**
	Sed & Met	164.7	13.2	30.4			137.9	15.2	**361**

Road-related granitic sediment contribution in Scott River watershed derived from SEDMODL2 & RM road survey.		Stream Crossing Failures	Road-Related Gullies	Fill Failures	Cutbank Failures	Road Related Mass Movement	Road Tread Sediment Delivery	Cut-slope Sediment Delivery	Total Delivery
West Canyon	Granitic	3.8	20.3	2.7	0.3		105.7	35.5	**168**
East Canyon									
Eastside									
East Headwater		2.4	12.8	1.8	0.2		68.7	23.1	**109**
West Headwater		8.8	50.2	7.1	0.8		252.0	84.8	**404**
Westside		28.6	163.7	23.5	2.7		789.9	278.2	**1287**
Scott Valley									

Road-related granitic sediment contribution in Scott River watershed derived from Granitic Sediment Study.		Fill - slope Sediment Delivery	Road Tread Sediment Delivery	Cut-slope/ Cutbank Sediment Delivery	Total Delivery
West Canyon	Granitic	9.6	92.1	246.1	**348**
East Canyon					
Eastside					
East Headwater		6.4	61.5	164.3	**232**
West Headwater		23.6	227.2	606.9	**858**
Westside		77.7	715.1	1997.0	**2790**
Scott Valley					

Estimated Total Sediment Delivery by Subwatershed

Watershed Totals using SEDMODL2 & RM road survey delivery rates for all geologic units	West Canyon	East Canyon	Eastside	East Headwater	West Headwater	Westside	Scott Valley	Sediment contribution by subwatershed (tons/yr)	Sediment contribution by subwatershed (tons/sq mi-yr)
Total Contribution by subwatershed (tons/yr)	695	1270	1254	1411	807	2533	964	***8940***	***11***
subwatershed (tons/sq mi-yr)	7	11	11	32	5	16	1		

Watershed Totals using SEDMODL2 & RM road survey delivery rates for all geologic units except granitic substrate. Delivery rates for granitic substrate derived from Granitic Sediment Study.	West Canyon	East Canyon	Eastside	East Headwater	West Headwater	Westside	Scott Valley	Sediment contribution by subbasin (tons/yr)	Sediment contribution by subwatershed (tons/sq mi-yr)
Total Contribution by subwatershed (tons/yr)	875	1270	1254	1535	1261	4036	964	***11200***	***14***
subwatershed (tons/sq mi-yr)	9	11	11	35	7	26	1		

Table 3.8. Comparison of granitic sediment delivery in the Scott River watershed relying only on SEDMODL2 and road survey versus incorporating results of Granitic Sediment Study (Sommarstrom et al., 1990) for granitic areas.

	Not using GSS (Source: Table 3.7)	Using GSS (Source: Table 3.7)	Percent greater using GSS
West Canyon (tons/yr)	695	875	**26%**
East Headwater (tons/yr)	1411	1535	**9%**
West Headwater (tons/yr)	807	1261	**56%**
Westside (tons/yr)	2533	4036	**59%**

Table 3.9. Summary of the number of features photointerpreted as possible landslides in Vestra photoanalysis.

Subwatershed	Feature type	Photo-interpreted features that have been field verified												Active Delivering	NOT Delivering
		No. of Active slide features Delivering			No. of Active slide features Not delivering			No. of Inactive slide features (Not delivering)			No. of slide features that are NOT slides not delivering				
		Line	Point	Polygon	Line	Point	Polygon	Line	Point	Polygon	Line	Point	Polygon		
WEST CANYON	Granitic	1	2	2		1	1		2					5	4
	Mafic	2		3	2	4	3	1		3	1	1	6	5	21
	Sed & Met	2	5	4	4	2	1			10		3	6	11	26
EAST CANYON	Granitic														
	Mafic							4	1	2					7
	Sed & Met							1	1			1			3
EASTSIDE	Granitic														
	Mafic														
	Sed & Met														
EAST HEADWATER	Granitic														
	Mafic	1				1		1	1					1	3
	Sed & Met														
WEST HEADWATER	Granitic			1					1					1	1
	Mafic				1	3	1				1				6
	Sed & Met														
WESTSIDE	Granitic														
	Mafic														
	Sed & Met														
SCOTT VALLEY	Granitic														
	Mafic														
	Sed & Met														
												TOTALS		*23*	*71*

Subwatershed	Feature type	Photo-interpreted features that have NOT been field verified									Full connect	Partial connect	NON connect
		No. of features interpreted to be fully hydrologically connected			No. of features interpreted to be partially hydrologically connected			No. of features interpreted NOT to be hydrologically connected					
		Line	Point	Polygon	Line	Point	Polygon	Line	Point	Polygon			
WEST CANYON	Granitic								1				1
	Mafic	8	5	9	11	12	4	2	5		22	27	7
	Sed & Met	11	20	18	6	8	13	1	7	8	49	27	16
EAST CANYON	Granitic												
	Mafic												
	Sed & Met	1	2	2		2	1		1	1	5	3	2
EASTSIDE	Granitic												
	Mafic												
	Sed & Met					1		1		2		1	3
EAST HEADWATER	Granitic												
	Mafic	2						2	1	1	2		4
	Sed & Met	1				1				1	1	1	1
WEST HEADWATER	Granitic		1							1	1		1
	Mafic					1						1	
	Sed & Met												
WESTSIDE	Granitic	6	7	8	1	8	3	2	4	2	21	12	8
	Mafic		1		1	1	1				1	3	
	Sed & Met	1	5	6	7	5	9	1	4	3	12	21	8
SCOTT VALLEY	Granitic												
	Mafic												
	Sed & Met				1	1		1		1		2	2
								TOTALS			*114*	*98*	*53*

Table 3.10. Summary of the sediment delivery from features photointerpreted as possible landslides in Vestra photoanalysis.

Human activity related		Photo-interpretation of slide features															
Subwatershed	Geologic Unit	Features field verified			Features that have NOT been field verified									*TONS Delivered*			
		Tons/yr sediment delivered			Tons/yr sediment delivered from features interpreted as "fully hydrologically connected"			Tons/yr sediment delivered from features interpreted as "partially hydrologically connected"			Tons/yr sediment delivered from features interpreted as "not hydrologically connected"			Tons/ year- geology	Tons/ year- subwatershed	Tons/ year- sq mi- subwatershed	Tons/ year- sq mi-Scott River
		Line	Point	Polygon	Line	Point	Polygon	Line	Point	Polygon	Line	Point	Polygon				
WEST CANYON	Granitic		3	2906								0		2909			
	Mafic	36		953	32	1	1844	10	0	1109		1		3987	22555	229	
	Sed & Met	118	1	7108	13	6	7055	23	1	907		1	425	15660			
EAST CANYON	Granitic																
	Mafic														1896	19	
	Sed & Met				30	2	1800		1			0	64	1896			
EASTSIDE	Granitic																
	Mafic														0	0	
	Sed & Met								0					0			
EAST HEADWATER	Granitic																
	Mafic	19			52						10	0		81	82	1	*36*
	Sed & Met								0					0			
WEST HEADWATER	Granitic																
	Mafic			1526					0					1527	1527	35	
	Sed & Met																
WESTSIDE	Granitic				89	1	571		2	228		1		890			
	Mafic					1								1	3244	18	
	Sed & Met					1		16	1	2335		0		2353			
SCOTT VALLEY	Granitic																
	Mafic														70	0	
	Sed & Met								0		3		66	70			

Not human activity related		Photo-interpretation of slide features															
Subwatershed	Geologic Unit	Features field verified			Features that have NOT been field verified									*Tons Delivered*			
		Tons/yr sediment delivered			Tons/yr sediment delivered from features interpreted as "fully hydrologically connected"			Tons/yr sediment delivered from features interpreted as "partially hydrologically connected"			Tons/yr sediment delivered from features interpreted as "not hydrologically connected"			Tons/ year- geology	Tons/ year- subwatershed	Tons/ year- sq mi- subwatershed	Tons/ year- sq mi-Scott River
		Line	Point	Poly	Line	Point	Poly	Line	Point	Poly	Line	Point	Poly				
WEST CANYON	Granitic			398										398			
	Mafic			812	143	4	3993	85	4		11	1		5053	10982	111	
	Sed & Met		5		132	13	5345	28	1		8	0		5531			
EAST CANYON	Granitic																
	Mafic																
	Sed & Met																
EASTSIDE	Granitic																
	Mafic														6	0	
	Sed & Met										6	0		6			
EAST HEADWATER	Granitic																
	Mafic				17									17	34	0	*23*
	Sed & Met				17									17			
WEST HEADWATER	Granitic			364		1								365			
	Mafic														365	8	
	Sed & Met																
WESTSIDE	Granitic				165	6	4282	10	0		16	1		4479			
	Mafic							16	0					16	7176	40	
	Sed & Met				58	4	2539	70	1		9	0		2681			
SCOTT VALLEY	Granitic																
	Mafic														8	0	
	Sed & Met							8	0					8			

Table 3.11. Tons/year of landslide sediment intrepreted to be human-activity related.

Subwatershed	Geologic Unit	Mining Association (tons/yr)	Road Association (tons/yr)			Harvest Association (tons/yr)			Road and Harvest Association (tons/yr)			Tons/ geology-year	Tons/ subwatershed-year	Tons/ sq mi-year subwatershed	Tons/ sq mi-year Scott River
			Line	Point	Polygon	Line	Point	Polygon	Line	Point	Polygon				
WEST CANYON	**Granitic**			0						3	2906	**2909**	**22554**	**229**	
	Mafic			0	817	42	1	3090	36	0		**3987**			
	Sed & Met		80	5	8605	36	1	425	38	2	6465	**15659**			
EAST CANYON	**Granitic**												**1896**	**19**	
	Mafic														
	Sed & Met		30	2	1800		0	64		0		**1896**			
EASTSIDE	**Granitic**												**0**	**0**	
	Mafic														
	Sed & Met						0					**0**			
EAST HEADWATER	**Granitic**												**82**	**1**	***36***
	Mafic		19			52			10	0		**81**			
	Sed & Met			0								**0**			
WEST HEADWATER	**Granitic**												**1527**	**35**	
	Mafic	1526								0		**1527**			
	Sed & Met														
WESTSIDE	**Granitic**			1		75	1	798	13	1		**890**	**3244**	**18**	
	Mafic						1					**1**			
	Sed & Met		5	1	1126		1		11	1	1209	**2353**			
SCOTT VALLEY	**Granitic**												**70**	**0**	
	Mafic														
	Sed & Met		3							0	66	**70**			
	Total (tons/yr)	***1526***		***Total (tons/yr)***	***12495***		***Total (tons/yr)***	***4589***		***Total (tons/yr)***	***10763***				

Table 3.12. Comparison of soil creep contribution estimates

Source of Estimate	South Fork Scott River SEDMODL2	S. Fork Eel*	Trinity R.**	Scott River Estimate Used
Tons/sq mi/year	***24***	***21***	***30***	***29***

*Stillwater Sciences (1999)
**Graham Matthews & Associates (2001)

Table 3.13. Soil creep contribution estimates in seven subwatersheds Scott River watershed including stream miles in granite bedrock.

Subwatershed	Stream Miles	Area (sq mi)	Total Delivery (tons/yr)	Soil Creep (tons/sq mi-yr)
West Canyon	314	99	3267	33
East Canyon	356	100	3699	37
Eastside	416	121	4322	36
East Headwater	362	115	3767	33
West Headwater	122	44	1271	29
Westside	528	179	5491	31
Scott Valley	401	156	2084	13
Totals	***2500***	***813***	***23902***	***29***

Table 3.14. Soil creep contribution estimates in seven subwatersheds Scott River watershed. Stream miles and area in granite are not included here but are included in Table 3.19 in the calculation of granite streamside contribution.

Subwatershed	Stream Miles	Area (sq mi)	Total Delivery (tons)	Soil Creep (tons/sq mi-yr)
West Canyon	289	75	3001	40
East Canyon	356	95	3699	39
Eastside	416	111	4322	39
East Headwater	342	66	3554	54
West Headwater	63	28	657	24
Westside	375	157	3893	25
Scott Valley	401	144	2084	14
Totals	***2241***	***676***	***21211***	***31***

Table 3.15. Summary of estimated management contribution to stream sediment by large and small discrete features along stratified random samples of stream segments in the Scott River watershed.

Stream reach ID	Total Contribution (tons)	Human-Activity Related Contribution	Upslope management influences and comments
QUATERNARY			
Q-01-04	110	0	No visible anthropogenic influences in the field or on aerial photos
Q-02-04	1539	1	Sample survey reach is within the bounds of a timber harvest unit. Documented management-related slide and sediment inputs.
Q-03-04	105	1	Field observations indicate 2 failed stream crossings, also indicate channel torrented, but not included in USFS flood altered inventory.
Q-04-04	1809	0.5	Field observation, landslide has road passing through unstable area, visited in May 2004. Also documented road damage delivery to stream.
Q-05-04	0	0.25	Small percentage of high impact 90's harvests. Moderately high road density. No documented management related slides or sediment inputs.
Q-06-04	0	1	Failed stream crossing at top of sample survey reach : Low impact 1995 timber harvest units within 150-500 ft upslope of entire survey length.
Q-07-04	0	0	Minimal harvest activity. Moderatly high road density. No documented management related slides or sediment inputs.
Q-08-04	1013	1	Numerous management related slides documented within the subbasin
Q-09-04	0	1	Low impact 90's and medium to high impact 2000 timber harvest units. Moderate road density and stream crossings. Extensive past mining activity.
Q-10-04	0	N/A	Mainstem Scott River. Not included in calculation.
Q-11-04	0	0	Low percentage of roads, stream crossings, and (low impact) timber harvest activity. No documented management related slides or sediment inputs.
Q-12-04	0	N/A	Mainstem Scott River. Not included in calculation.
	4576	***0.78***	***Streamside sampling percentage : 3.4 miles of 199.3 miles (1.7%)***
GRANITIC			
G-01-03			Subbasin area above sampled reach of insufficient size to be included.
G-02-03			Subbasin area above sampled reach of insufficient size to be included.
G-03-03	0	0	No visible anthropogenic influences in the field or on aerial photos
G-04-04	32	0	Low percentage of roads, stream crossings, and (low impact) timber harvest activity. No documented management related slides or sediment inputs.
G-05-04	0	0	No visible anthropogenic influences in the field or on aerial photos
G-06-04	1013	0	Limited logging, wilderness area, slides within subbasin appear to be from natural causes.
G-07-04	3048	0	Some legacy roads visible on aerial photos, no other visible anthropogenic influences in the field or on aerial photos
G-08-04	1884	0	Small, medium impact 1979 harvest adjacent survey reach. No documented roads, management related slides or sediment inputs.
G-09-04	899	0	Some legacy roads visible on aerial photos, no other visible anthropogenic influences in the field or on aerial photos
G-10-04	2106	0	No visible anthropogenic influences in the field or on aerial photos
G-11-04	0	0	Some pre-1990 harvest activity, moderate road density. No documented management related slides or sediment inputs.
G-12-04	0	0	Some legacy roads visible on aerial photos, no other visible anthropogenic influences in the field or on aerial photos
G-13-04	1836	0.25	1996 timber harvest located just upstream of sample survey reach.
G-14-04	2856	0.5	Sample survey reach is completely within the bounds of a timber harvest unit.
G-15-04	2003	0	Low impact 1980 harvest, low road density. Slides attributed to natural causes. No documented management related slides or sediment inputs.
G-16-04	11	0.25	2001 harvest activity, moderate road density, high number of stream crossings.
G-17-04	34	0.5	45% post 1990 medium to high impact timber harvest activity. Moderate road density.
G-18-04	809	0.75	High impact timber harvest activity post 1987 fire. Numerous documented management related slides and sediment inputs.
G-19-04	741	0.75	High impact timber harvest activity post 1987 fire. Numerous documented management related slides and sediment inputs.
	17270	***0.18***	***Streamside sampling percentage : 6.2 miles of 258.9 miles (2.4%)***
MAFIC / ULTRAMAFIC			
M-01-03	108	0.5	Approximately 65-70% high impact timber harvest activity post 1987 fire.
M-02-03	5702	1	Field observations indicate mudflow deposits being excavated by stream, at bottom end of large clearcut.
M-03-03			Subbasin area above sampled reach of insufficient size to be included.
M-04-03			Subbasin area above sampled reach of insufficient size to be included.
M-05-03	0	0.25	Approximately 80% pre 1990 timber harvest activity within the subbasin.
M-06-03	0	0.25	High road density, moderate amount of stream crossings and length of roads within 100ft of the stream channel.
M-07-03	50	0.25	Field observation: stumps and cut logs buried in sediments, indications of mudflows post harvest
M-08-03	18	0	Low road density, minimal timber harvest activity. No documented management related slides or sediment inputs.
M-09-04	564	0	Low road density, minimal timber harvest activity. No documented management related slides or sediment inputs.
M-10-04	0	0.5	Moderate road density and number of stream crossings. Past mining activity and documented management related slides and sediment inputs.
M-11-04	193	0.5	Moderate road density and number of stream crossings. Past mining activity and documented management related slides and sediment inputs.
M-12-04	122	0	Some legacy roads visible on aerial photos, no other visible anthropogenic influences in the field or on aerial photos
M-13-04	0	0	Low road density, minimal 40 year old timber harvest activity. No documented management related slides or sediment inputs.
M-14-04	0	0.75	Medium to high impact mid 80's and 2000 timber harvest activity. Numerous documented management related slides and sediment inputs.
M-15-04	134	0.75	Moderate amount of timber harvest acitivity. High road density and number of stream crossings. Documented management related slides.
M-16-04	0	N/A	Mainstem Scott River. Not included in calculation.
M-17-04	184	0.75	Documented sediment inputs from State Highway 3 seen in the field Moderate amount of medium to high impact 1999 timber harvest activity.
M-18-04	509	0.75	High impact timber harvest activity post 1987 fire. Numerous documented management related slides and sediment inputs.
M-19-04	3629	0.25	Sample survey reach is completely within the bounds of a timber harvest unit. Moderate road density and number of stream crossings.
	11212	***0.66***	***Streamside sampling percentage : 7.5 miles of 400.5 miles (1.9%)***
SEDIMENTARY / METAMORPHIC			
S-01-03	0	0.75	Sample survey reach is completely within the bounds of a 1993 timber harvest unit. Approximately 36% of the subbasin previously harvested.
S-02-03	0	0.75	High impact 1990 timber harvest. High road density and number of stream crossings. Approximately 38% of the subbasin previously harvested.
S-03-04	0	0.5	Moderate road density and stream crossings. Numerous documented management related slides and sediment inputs. Extensive past mining activity.
S-04-04	0	0	No visible anthropogenic influences in the field or on aerial photos
S-05-04	313	0.25	Approximately 60% of the subbasin in 1997 low impact timber harvest. Slides related to management causes, but determined to be partially delivering.
S-06-04	13	0.25	Moderate road density and stream crossings. Documented management related sediment input.
S-07-04	4806	0	No visible anthropogenic influences in the field or on aerial photos
S-08-04	0	0	No visible anthropogenic influences in the field or on aerial photos
S-09-04	1245	0.75	Moderate road density and stream crossings. Approximately 25% harvested. Documented management related slides and sediment inputs.
S-10-04	182	0	No visible anthropogenic influences in the field or on aerial photos
S-11-04	0	0	No visible anthropogenic influences in the field or on aerial photos
S-12-04	101	0	Minimal harvest, low road density, slide activity related to natural causes.
S-13-04	1292	0.25	Low impact 1999 and 200 timber harvests. Low road density and stream crossings. Documented slides from natural causes.
	7952	***0.17***	***Streamside sampling percentage : 4.2 miles of 1641.4 miles (0.3%)***

Table 3.16. Estimate of sediment contribution from streamside large discrete features in the Scott River watershed assuming management and non-management contributions in the ratio estimated in Table 3.15.

Geologic unit	Area sq mi	Stream miles	Tons/ stream mi-year	Tons/year-Geologic unit	Anthropogenic Contribution factor (Table 3.15)	Tons/year Human-Activity Associated	Tons/year Natural
Quaternary	15	49	14	708	0.78	551	157
Mafic	125	377	132	49947	0.66	32930	17017
Sed & Met	431	1414	29	40435	0.17	6806	33629
Watershed totals (Granitic excluded)	*571*	*1840*	*175*	*91089*		*40287*	*50802*
				Tons/sq mile-year		*71*	*89*

Geologic unit	Area sq mi	Stream miles	Tons/ stream mi-year	Tons/year-Geologic unit	Anthropogenic Contribution factor (Table 3.15)	Tons/year Human-Activity Associated	Tons/year Natural
Granitic	86	259	87	22631	0.18	4022	18609
				Tons/sq mile-year		*47*	*217*

		Tons/year Human-Activity Associated	Tons/year Natural
Watershed totals (Granitic included)	*Tons/year*	*44309*	*69411*
	Tons/sq mile-year	*67*	*106*

Table 3.17. Estimate of sediment contribution from streamside large discrete features in each subwatershed assuming management and non-management contributions in the ratio estimated in Table 3.15.

Subwatershed	Geology Type	Area (sq mi)	Stream Length (miles)	Human-Activity Contribution factor (table 3.15)	Tons/yr Human-Activity Associated	Tons/yr Natural
West Canyon	Quaternary	1	5	0.78	59	17
	Mafic	24	78	0.66	6842	3536
	Sed & Met	66	205	0.17	987	4876
East Canyon	Quaternary	1	4	0.78	41	12
	Mafic	5	16	0.66	1414	731
	Sed & Met	95	336	0.17	1618	7993
Eastside	Quaternary	0	0	0.78	0	0
	Mafic	10	33	0.66	2842	1468
	Sed & Met	111	383	0.17	1845	9116
East Headwater	Quaternary	5	17	0.78	192	55
	Mafic	49	148	0.66	12938	6686
	Sed & Met	54	177	0.17	850	4201
West Headwater	Quaternary	1	3	0.78	36	10
	Mafic	16	41	0.66	3561	1840
	Sed & Met	6	19	0.17	92	456
Westside	Quaternary	7	20	0.78	222	63
	Mafic	21	61	0.66	5334	2756
	Sed & Met	100	294	0.17	1414	6986

Subwatershed	Geology Type	Area (sq mi)	Stream Length (miles)	Human-Activity Contribution factor (table 3.15)	Tons/yr Human-Activity Associated	Tons/yr Natural
West Canyon	Granitic	7	26	0.18	399	1845
East Canyon		0	0		0	0
Eastside		0	0		0	0
East Headwater		7	20		317	1468
West Headwater		21	59		917	4244
Westside		50	154		2389	11053

Estimated Subwatershed Sediment Delivery Totals

		Human activity associated		Natural	
		Tons/yr	Tons/sq mi-year	Tons/yr	Tons/sq mi-year
West Canyon	Subwatershed Totals (tons/yr) (SEDMODL2 & RM road survey delivery rates for all geologic units)	8287	84	10274	104
East Canyon		3073	31	8735	87
Eastside		4687	39	10585	88
East Headwater		14297	124	12409	108
West Headwater		4607	105	6550	149
Westside		9358	52	20858	117
TOTALS		***44309***	***55***	***69411***	***85***

		Human activity associated		Natural	
		Tons/yr	Tons/sq mi-year	Tons/yr	Tons/sq mi-year
West Canyon	Subwatershed Totals (tons/yr) (SEDMODL2 & RM road survey delivery rates for all geologic units except Granitics)	7888	86	8429	92
East Canyon		3073	34	8735	97
Eastside		4687	66	10585	148
East Headwater		13980	140	10942	109
West Headwater		3690	37	2307	23
Westside		6969	67	9806	94
TOTALS		***40287***	***50***	***50802***	***63***

Table 3.18. Computation of sediment contribution by streamside small features using data from stream surveys in all geologic units.

		Associated with Human Activity				Direct Association with Human Activity NOT Observed Within Stream Reach				Contribution	
		Quaternary	Granitic	Mafic	Sedimentary Metamorphic	Quaternary	Granitic	Mafic	Sedimentary Metamorphic	Total Contribution tons/year	Total Contribution tons/sq mi-year
Total number of streamside surveys		12	19	19	13	12	19	19	13		
Survey segments with streamside discrete small features		2	3	6	2	6	12	10	7		
Average sediment input (cubic meters/stream meter/year)		0.005	0.014	0.016	0.009	0.093	0.065	0.022	0.048		
Cubic meters per stream mile		7.8	21.8	25.8	14.9	150.5	104.1	34.8	77.9		
Stream miles		199	259	401	1641	199	259	401	1641		
Cubic meters per year		1550	5653	10336	24505	29990	26949	13937	127920		
Tons per year		***2721***	***9921***	***18140***	***43007***	***52633***	***47296***	***24460***	***224499***		
Human-Activity Related Source	**Roads**	782	1540	16259							
	Timber Harvest		684		43007						
	Agriculture / Mining			1526							
	EMIHA[1]	1939	7698								
Anthropogenic Contribution factor (Table 3.15)						0.78	0.18	0.66	0.17		
Totals Associated with Human Activity (less roads source values)		***1939***	***8382***	***1526***	***43007***	***40966***	***8405***	***16127***	***37788***	***158140***	***195***
Totals of Natural Contribution						***11667***	***38891***	***8333***	***186710***	***245602***	***302***

1 EMIHA (Effects of Multiple Interacting Human Activities)

Table 3.19. Computation of sediment contribution by streamside small features using data from stream surveys in Quaternary, Mafic, and Sedimentary/Metamorphic geologic units. The Scott Granitic Sediment Study of Sommarstrom and others (1990) was used in Granitic areas.

		Associated with Human Activity				Direct Association with Human Activity not Observed Within Stream Reach				Contribution	
		Quaternary	Granitic	Mafic	Sedimentary Metamorphic	Quaternary	Granitic	Mafic	Sedimentary Metamorphic	Total Contribution tons/year	Total Contribution tons/sq mi-year
Total number of streamside surveys		12		19	13	12	Granitic Sediment Study	19	13		
Survey segments with streamside discrete small features		2		6	2	6	Includes Streamside Large features, Streamside Small features, and Soil Creep. In the study, there was no differentiation in contribution due to any human activity.	10	7		
Average sediment input (cubic meters/stream meter/year)		0.005		0.016	0.009	0.093		0.022	0.048		
Cubic meters per stream mile		7.8		25.8	14.9	150.5		34.8	77.9		
Stream miles		199		401	1641	199		401	1641		
Cubic meters per year		1550		10336	24505	29990		13937	127920		
Tons per year		***2721***		***18140***	***43007***	***52633***	***56016***	***24460***	***224499***		
Human-Activity Related Source	Roads	782		16259							
	Timber Harvest				43007						
	Agriculture / Mining			1526							
	EMIHA[1]	1939									
Anthropogenic Contribution factor (Table 3.15)						0.78	0.18	0.66	0.17		
Totals Associated with Human Activity (less roads source values)		***1939***		***1526***	***43007***	***40966***	***9955***	***16127***	***37788***	***151308***	***186***
Totals of Natural Contribution						***11667***	***46062***	***8333***	***186710***	***252773***	***311***

1 EMIHA (Effects of Multiple Interacting Human Activities)

Table 3.20. Estimate of sediment contribution from streamside small discrete features that do not have direct human activity association observed within the stream reach in which they occur.

Subwatershed	Geology Type	Area (sq mi)	Stream Length (miles)	*Direct Association with Human Activity NOT Observed Within Stream Reach* Total Delivery (tons)	Human-Activity Contribution factor (Table 3.15)	Tons/yr Human-Activity Associated	Tons/yr Natural
West Canyon	Quaternary	1	5	1384	0.78	1077	307
	Mafic	24	78	4789	0.66	3158	1632
	Sed & Met	66	205	28042	0.17	4720	23322
East Canyon	Quaternary	1	4	968	0.78	753	215
	Mafic	5	16	990	0.66	652	337
	Sed & Met	95	336	45964	0.17	7737	38227
Eastside	Quaternary						
	Mafic	10	33	1989	0.66	1311	678
	Sed & Met	111	383	52425	0.17	8824	43600
East Headwater	Quaternary	5	17	4502	0.78	3504	998
	Mafic	49	148	9056	0.66	5971	3085
	Sed & Met	54	177	24160	0.17	4067	20094
West Headwater	Quaternary	1	3	854	0.78	665	189
	Mafic	16	41	2493	0.66	1643	849
	Sed & Met	6	19	2622	0.17	441	2181
Westside	Quaternary	7	20	5192	0.78	4041	1151
	Mafic	21	61	3733	0.66	2461	1272
	Sed & Met	100	294	40177	0.17	6763	33414
Valley Floor	Quaternary	65	150	39733	0.78	30925	8808
	Mafic	11	23	1410	0.66	930	481
	Sed & Met	79	227	31109	0.17	5236	25872

Subwatershed	Geology Type	Area (sq mi)	Stream Length (miles)	*Direct Association with Human Activity NOT Observed Within Stream Reach* Total Contribution (tons)	Human-Activity Contribution factor (Table 3.15)	Tons/yr Human-Activity Associated	Tons/yr Natural
West Canyon	Granitic	7	26	4690	0.18	833	3856
East Canyon							
Eastside							
East Headwater		7	20	3730		663	3067
West Headwater		21	59	10785		1917	8868
Westside		50	154	28091		4992	23099
Valley Floor							
GSS		86	259	56016	0.18	9955	46062

Estimated Subwatershed Sediment Delivery Totals

			Subwatershed Contribution Totals (Natural)				
			Tons/yr	**Tons/sq mi-year**		**Tons/yr**	**Tons/sq mi-year**
West Canyon		***SEDMODL2 & RM road survey delivery rates for all geologic units***	29117	295	***SEDMODL2 & RM road survey delivery rates for all geologic units except GSS delivery rates for Granitics***	29828	302
East Canyon			38779	387		38779	387
Eastside			44278	367		44278	367
East Headwater			27244	236		27810	241
West Headwater			12088	276		13723	313
Westside			58936	330		63195	354
Valley Floor			35161	226		35161	226
TOTALS			***245602***	***302***		***252773***	***311***

Table 3.21. Estimate of sediment contributions from streamside small discrete features that have documented association with human activity in the stream reach in which they occur.

Subwatershed	Geology Type	Area (sq mi)	Stream Length (miles)	Human Activity Related Source (rates in tons/year): Roads	Timber Harvest	Agriculture/ Mining	EMIHA[1]
West Canyon	Quaternary	1	5	21			51
	Mafic	24	78	3183		299	
	Sed & Met	66	205		5372		
East Canyon	Quaternary	1	4	14			36
	Mafic	5	16	658		62	
	Sed & Met	95	336		8805		
Eastside	Quaternary						
	Mafic	10	33	1322		124	
	Sed & Met	111	383		10043		
East Headwater	Quaternary	5	17	67			166
	Mafic	49	148	6019		565	
	Sed & Met	54	177		4628		
West Headwater	Quaternary	1	3	13			31
	Mafic	16	41	1657		156	
	Sed & Met	6	19		502		
Westside	Quaternary	7	20	77			191
	Mafic	21	61	2482		233	
	Sed & Met	100	294		7697		
Valley Floor	Quaternary	65	150	590			1464
	Mafic	11	23	937		88	
	Sed & Met	79	227		5959		

Subwatershed	Geology Type	Area (sq mi)	Stream Length (miles)	Human Activity Related Source (rate in tons/year): Roads	Timber Harvest	Agriculture/ Mining	EMIHA[1]
West Canyon	Granitic	7	26	153	68		763
East Canyon							
Eastside							
East Headwater		7	20	121	54		607
West Headwater		21	59	351	156		1755
Westside		50	154	914	406		4572
Valley Floor							

Estimated Subwatershed Sediment Delivery Totals

Includes Human Activity values from Table 3.20			Subwatershed Contribution Totals: Tons/yr	Tons/sq mi-year		Tons/yr	Tons/sq mi-year
West Canyon		*SEDMODL2 & RM road survey delivery rates for all geologic units (less roads source values)*	16341	166	*SEDMODL2 & RM road survey delivery rates for all geologic units except Granitics (less roads source values)*	15664	159
East Canyon			18045	180		18045	180
Eastside			20303	168		20303	168
East Headwater			20224	175		19686	171
West Headwater			7267	166		5709	130
Westside			31357	176		27299	153
Valley Floor			44603	582		44603	287
TOTALS			***158140***	***195***		***151308***	***186***

Table 3.22 Scott River Watershed Sediment Source Summary (tons/sq mi-year) used for TMDL. Granitic sediment study used for road delivery [1].

Subwatershed	Natural Processes Delivery (tons/sq mi-year)				
	[2] Landslide	[3] Large Discrete Features	[4] Small Discrete Features	[5] Soil Creep	Unique Landslide Features
West Canyon	111	104	295	33	
East Canyon	0	87	387	37	
Eastside	0	88	367	36	
East Headwaters	0	108	236	33	
West Headwaters	8	149	276	29	140
Westside	40	117	330	31	
Scott Valley	0	0	226	13	
Watershed Totals (Tons/sq mi-yr)	***23***	***85***	***302***	***29***	***8***
	(Table 3.10)	*(Table 3.17)*	*(Table 3.20)*	*(Table 3.12)*	*(Report Text)*

Subwatershed	Human-Activity Processes Related Delivery (tons/sq mi-year)				
	[2] Landslide	[3] Large Discrete Features	[4] Small Discrete Features	[6] Road-Related (granitic contribution derived from Granitic Sediment Study)	Unique Landslide Features
West Canyon	132	84	166	105	
East Canyon	1	31	180	31	
Eastside	0	39	168	10	
East Headwaters	1	124	175	13	
West Headwaters	35	105	166	29	9
Westside	12	52	176	29	
Scott Valley	0	0	287	6	
Watershed Totals (Tons/sq mi-yr)	***21***	***55***	***195***	***29***	***0***
	(Table 3.11)	*(Table 3.17)*	*(Table 3.21)*	*(Table 3.7)*	*(Report Text)*

Sediment Delivery SUMMARY	Total Natural Delivery	Total Human-Activity Related Delivery	Total Delivery	Percentage Above Natural
West Canyon	544	487	1031	***90%***
East Canyon	511	242	754	***47%***
Eastside	491	218	709	***44%***
East Headwaters	377	314	691	***83%***
West Headwaters	602	343	945	***57%***
Westside	518	269	786	***52%***
Scott Valley	239	293	533	***123%***
Watershed Totals (Tons/sq mi-yr)	***447***	***299***	***746***	***67%***

1 Minor errors in addition due to rounding differences
2 Landslides derived from VESTRA Resources landslide analysis (excluding road-related landslides)
3 Large Discrete Features derived from Stream Surveys all geologic units
4 Small Discrete Features derived from Stream Surveys all geologic units
5 Soil Creep derived from SEDMODL2 parameters
6 Road Related derived from SEDMODL2 and Resources Management road survey all geologic units except Granitic (including road-related landslides)

Table 3.23. Load Allocations for Sediment

Sources NOT Associated With Human Activity	Current Loading Estimate (tons/sq mi-yr)	Load Allocation (tons/sq mi-yr)	Reduction Needed (%)	
Landslides [1]	23	23	0%	*(Table 3.10)*
Streamside Sediment Delivery				
Large Features	93	93	0%	*(Table 3.17)*
Small Features	302	302	0%	*(Table 3.18)*
Soil Creep	29	29	0%	*(Table 3.12)*
Subtotal (Natural Sources)	***448***	***448***	***0%***	
Sources Associated With Human Activity	**Current Loading Estimate (tons/sq mi-yr)**	**Load Allocation (tons/sq mi-yr)**	**Reduction Needed (%)**	
Road Related				
Road Surface Erosion	4	2	54%	*(Table 3.6)*
Road-Stream Crossing Failures	3	1	71%	*(Table 3.6)*
Road Related Gullying	1	1	31%	*(Table 3.6)*
Road Related Cut/Fill Failures	4	1	76%	*(Table 3.6)*
Road Related Landslides [1]	16	7	56%	*(Table 3.11)*
Landslides				
Harvest Related	19	9	52%	*(Table 3.11)*
Mining Related [1]	2	2	0%	*(Table 3.11)*
Streamside Sediment Delivery				
Large Features				
EMIHA[2]	55	17	69%	*(Table 3.22)*
Small Features				
Harvest Related	54	20	63%	*(Table 3.18)*
Mining Related	2	2	0%	*(Table 3.18)*
EMIHA[2]	139	50	64%	*(Table 3.18)*
Subtotal (Human Activity)	***299***	***112***	***63%***	
Total Contribution	747	560		
Percentage Above Natural Sources	67%	25%		
TMDL (tons/sq mi-year)	***560***			

1 **Includes unique landslide features reported in Table 3.22**
2 **EMIHA (Effects of Multiple Interacting Human Activities)**

Table 4.1: Data required for operation of the Heat Source model		
Type of data:	**Parameter**	**Comment**
Spatially Distributed Data:		Required at every computational node (every 100 meters in this analysis):
	Longitude (deg)	Derived from GIS
	Latitude (deg)	Derived from GIS
	Stream Elevation (m)	Derived from GIS
	Aspect (deg)	Derived from GIS
	Topo Shade Angle (deg) - West	Derived from GIS
	Topo Shade Angle (deg) - South	Derived from GIS
	Topo Shade Angle (deg) - East	Derived from GIS
	Gradient	Derived from GIS
	Mannings n	Calibration parameter in this analysis
	W:D Ratio	Based on Rosgen channel type
	Bankfull Width (m)	Digitized from aerial imagery, used
	Channel Angle -z	Channel side slope
	X Factor (0.0-0.5)	Hydraulic storage factor
	Bed Particle Size (mm)	Estimated from habitat typing data and professional judgment, used in hyporheic calculations
	Horizontal Bed Conductivity (mm/s)	Estimated from bed particle sizes, used in hyporheic calculations
	Embeddedness	Estimated from habitat typing data and professional judgment, used in hyporheic calculations
	Valley Aspect (degrees)	Derived from GIS, used in hyporheic calculations
	Accretion Flow (cms)	Developed from flow measurements and FLIR data
	Withdrawal Flows (cms)	Estimated form water rights and discussions with diversion operator
Upstream Boundary Condition:		Information used to define starting conditions
	Flow (cms)	Based on flow measurements
	Stream Temperature (*C)	Measured
Continuous Data:		Required for every hour of simulation
	Cloudiness (0-1)	Based on solar radiation data
	Wind Speed (m/s)	Measured in some locations, extrapolated to other locations
	Relative Humidity (%)	Measured
	Air Temp (*C)	Measured
	Stream Temp (*C)	Measured
Tributary Information:		
	Inflow Rate (cms)	Estimated based on measurements, drainage arreas, or FLIR data
	Inflow Temp (*C)	Most measured, some minor tribs estimated using records from similar streams
Land Cover Information:		
	Height (m)	Estimated from measurements
	Density (%)	Estimated using default values
	Overhang (m)	Set to 0

Table 4.2 : Continuous Data Used in the Development of Temperature Modeling Applications

Modeling Scenario	Water Temperature Sites, Validation Data	Water Temperature Sites, Boundary Conditions	Air Temperature Sites	Relative Humidity Data	Windspeed Data	Flow Data
Scott River: Fay Lane to Klamath River	21 sites: River Mile (RM) 48.3 above French Ck RM 47.9 below French Ck RM 42.4 RM 41.8 RM 39.3 at Eller Lane RM 35.1 at Island Road RM 32.6 above Kidder Creek RM 31.9 below Kidder Creek RM 25.0 at Meamber Bridge RM 23.4 at Meamber Creek RM 21.5 at USGS Gage RM 18.6 at Jones Beach RM 16.1 above Canyon RM 15.8 below Canyon RM 14.2 below Kelsey Creek RM 13.3 at Deep Creek RM 10.8 at Townsend Gulch RM 8.0 below George Allen Gulch RM 4.7 below Big Ferry Creek RM 3.1 below Mill Creek RM 2.3 below Franklin Gulch	11 sites: RM 50.2 Scott River at Fay Ln RM 48.2 French Ck RM 32.5 Kidder Ck RM 16.2 Boulder Ck RM15.9 Canyon Ck RM 14.7 Kelsey Ck RM 13.2 Deep Ck RM 12.9 Middle Ck RM 11.7 Tompkins Ck RM 10.1 McCarthy Ck RM 3.6 Mill Ck	6 sites: RM 47.9 below French Ck RM 41.8 RM 32.6 above Kidder Ck RM 18.6 at Jones Beach RM 13.2 downstream of Deep Ck RM Tompkins Ck RM 0.6 at Roxbury Bridge	5 sites: RM 47.9 below French Ck RM 41.8 RM 32.6 above Kidder Ck RM 18.6 at Jones Beach RM 13.2 downstream of Deep Ck RM 0.6 at Roxbury Bridge	3 sites: RM 41.8 RM 32.6 above Kidder Ck RM 13.2 Downstream of Deep Ck	Flows were estimated from the continuous gage record at RM 21.5, periodic measurements at 10 other locations, and TIR data.
South Fork Scott River: Blue Jay Creek to Callahan	2 Sites: SF at South Fork Rd SF at Blue Jay Ck	3 Sites: SF upstream of road 41N21Y bridge Fox Creek (no data available, flow and temperatures estimated)	2 sites: Above Blue Jay Ck Callahan weather station at USFS facility	2 sites: Above Blue Jay Ck Callahan weather station at USFS facility	1 site: Callahan weather station at USFS facility	Flows were estimated from the preliminary continuous gage record at

		Boulder Creek (no data available, flow and temperatures estimated)				Callahan, periodic flow measurements above Blue Jay Ck, and TIR data.
East Fork Scott River: Houston Creek to Callahan	3 Sites: EF at Kangaroo Rd EF at Upper Masterson RD bridge EF at Callahan	5 sites: Rail Ck Ditch Grouse Ck Mule Ck Big Mill Ck Little Mill Ck (no data available at these sites, flow and temperatures estimated)	2 sites: Below Houston Ck Callahan weather station at USFS facility	2 sites: Below Houston Ck Callahan weather station at USFS facility	1 site: Callahan weather station at USFS facility	Flows were estimated from preliminary continuous gage record at Callahan, periodic flow measurements below Houston Ck, and TIR data.
Houston/ Cabin Meadows Creeks: Cabin Meadows Creek at Rd 41N10 to Houston Creek, Houston	6 Sites: Cabin Meadows Ck downstream of road 41N03 Cabin Meadows Ck upstream of Houston Creek Houston Ck downstream of Cabin Meadows Ck Houston Ck upstream of Little Houston Ck Houston Ck downstream of Little Houston Ck Houston Creek upstream of	3 sites: Cabin Meadows Ck at rd 41N10 crossing Houston Ck Little Houston Ck	5 Sites: Road 41N10 crossing Downstream of road 41N03 crossing Confluence of Houston and Cabin Meadows Cks Confluence of Houston and Little Houston Cks	5 Sites: Road 41N10 crossing Downstream of road 41N03 crossing Confluence of Houston and Cabin Meadows Cks Confluence of Houston and Little Houston Cks	1 site: Confluence of Houston and Crater Cks	Flows were estimated from measurements where Cabin Meadows Ck crosses roads 41N10 and 41N03, as well as temperatur

Creek to East Fork Scott River	Crater Ck		Confluence of Houston and Crater Cks	Confluence of Houston and Crater Cks		e records at tributary confluence s.

Table 4.3 Measured and Estimated Flows (cubic feet per second)

	River Mile	7/2 2003	7/3 2003	7/16 2003	7/25 2003	7/26 2003	7/28 2003	7/29 2003	7/30 2003	8/25 2003	8/26 2003	8/27 2003	8/28 2003	9/4 2003	9/9 2003	9/10 2003	9/11 2003	9/24 2003	9/25 2003	9/26 2003	10/7 2003	10/8 2003	10/9 2003
Mainstem																							
Scott River at Roxbury bridge	0.6				**155**		139		**123**			62				**81**	81				68		
Scott River at Townsend gulch	10.8				**150**			122	**119**			*57*			79	**79**		81			67		
Scott River u/s of Middle Creek	13.3											*50*						67			62		
Scott River at Jones beach	18.7				**98**			80	**77**			34			47	**47**		54			**43**	44	
Scott River at USGS gage, measured	21.6	310												47							48		
Scott River at USGS gage, rated final	21.6	327	302	154	135	141	121	110	107	42	43	41	39	46	48	48	48	52	52	52	56	58	57
Scott River d/s of Meamber bridge	25.1											27											
Scott River u/s of Kidder	32.5		193		**62**				49			21				23		**30**	30		28		
Scott River at Island Road	35.1		195		**61**				49			21				23		**30**					
Scott River at Sweazey's Bridge	41.8		179		**38**				30			*15*				16		**16**	16		13		
Scott River d/s of French Creek	47.7		183		**51**				40			*20*				22		**20**	20		**11**	12	
Scott River u/s of Fay lane	50.3				*32*				*26*			**11**	11			14		**13**	13		10		
Scott River at Alexander's	53.2		126																				
Scott River u/s of French Ck	48.1		**175**	67	**59**																		
Scott River d/s of French Ck	47.9		**170**	65	**57**																		
Scott River at Callahan, preliminary	56.9	154	141	72	95	82	49	48	43	24	23	23	23	27	30	28	27	23.2	22.3	22.2			
Tributaries																							
Lower Etna Creek		16.3										2.6											3.8
Upper Etna Creek												3.0							6.4				3.0
Upper East Fork							7.7				4.1						4.1			3.5	3.3		
Upper South Fork							13.4										8.5			8.2	6.6		
Upper Canyon										8.7		5.7						6.2					
Lower Canyon								**10.6**				7.0			**8.0**			8.2				5.5	
Kelsey Creek								5.5					3.7		4.1			4.2				2.8	
Kelsey Creek, w/ weir								7.3					4.9		4.1			4.2				2.8	
Kidder Slough			5.0						6.1														
Moffet Ck																			1.7				
Middle Slide Ck																				0.4			

Bold values are based on comparison of with flows at the gage

Italic values are based on a ratio of flows at a nearby site to flows at the site measured at some other time.

Table 4.4: Modeled and measured effective shade, mainstem Scott River

River Kilometer (Mile)	Modeled Effective Shade (%)	Measured Effective Shade (%)	Number of Samples	Difference (%)
80.8 - 80.6 (50.2 - 50.1)	8	8	3	0
67.3 - 66.8 (41.8 - 41.5)	2	2	6	0
56.6 - 56.2 (35.2 - 34.9)	18	17	5	1
52.5 - 52.2 (32.6 - 32.4)	12	12	4	-1
30 - 29.7 (18.6 - 18.5)	36	28	4	8
17.8 - 17.6 (11.1 - 10.9)	25	15	3	9

Table 4.5: Distribution of data used to define meteorological conditions						
Site #	**Site Name**	**River Mile**	**Collector**	**Wind Speed***	**Air Temp. ***	**Rel. Hum. ***
1	Scott River above French Creek	48.03	SRCD	4	4	4
2	Scott River below French Creek	47.73	SRCD	4	4	4
3	Scott River above Sweazey's Bridge	42.35	NCRWQCB	4	4	4
4	Scott River at Sweazey's Bridge	41.79	NCRWQCB	4	4	4
5	Scott River at Eller Lane	39.31	SRCD	4	4	4
6	Scott River at Island Road	35.05	SRCD	7	7	7
7	Scott River above (at) Kidder Creek	32.59	NCRWQCB	7	7	7
8	Scott River below Kidder Creek	31.89	SRCD	7	7	7
9	Scott River at Meamber Bridge	25.04	SRCD	7	7	7
10	Scott River at Meamber Creek	22.67	SRCD	7	7	7
11	Scott River at USGS Gage	21.60	USFS	16	12	12
12	Scott River at Jones Beach	18.80	USFS	16	12	12
13	Scott River above Canyon	16.10	USFS	16	16	16
14	Scott River below Canyon	15.80	USFS	16	16	16
15	Scott River below Kelsey Creek	14.24	USFS	16	16	16
16	Scott River at Deep Creek	13.31	USFS	16	16	16
17	Scott River at Townsend Gulch	10.85	USFS	16	Tompkins	16
18	Scott River Below George Allen Gulch	8.01	USFS	16	Tompkins	16
19	Scott River below Big Ferry Creek	6.31	USFS	16	Tompkins	16
20	Scott River below Pat Ford Creek	4.75	USFS	16	Tompkins	16
21	Scott River below Mill Creek	3.17	USFS	16	23	23
22	Scott River below Franklin Gulch	2.28	USFS	16	23	23
23	Scott River at Roxbury Bridge	0.50	USFS	16	23	23

* Numbers refer to the site where the data was collected.

Table 4.6A: Model Calibration results; Aug 27-Sept 10, 2003.									
River Mile	**River Kilometer**	**Site**	**Mean Absolute Error (C)**	**Average Bias (C)**	**Minimum Bias (C)**	**Maximum Bias (C)**	**Average Bias - Daily Min (C)**	**Average Bias - Daily Max (C)**	**Average Bias - Daily Average (C)**
48.3	77.7	Scott River above French Creek	0.7	-0.3	-2.8	1.9	-0.5	-0.7	-0.3
47.8	77	Scott River below French Creek	0.9	-0.3	-2.9	2.4	-0.4	-0.7	-0.3
42.4	68.2	Scott River above Sweazey's Bridge	1.2	0.2	-2.6	3.4	-0.4	-0.3	0.2
41.8	67.3	Scott River at Sweazey's Bridge	1.5	0.7	-2.9	4.3	0.1	-0.1	0.6
39.3	63.3	Scott River at Eller Lane	2.0	0.6	-5.0	4.0	1.1	-0.9	0.6
35.1	56.5	Scott River at Island Road	0.9	0.1	-2.7	2.5	-0.1	0.3	0.1
32.6	52.4	Scott River above Kidder Creek	0.8	-0.4	-3.1	2.0	-0.5	-0.8	-0.4
31.9	51.3	Scott River below Kidder Creek	0.6	-0.4	-2.5	1.7	-0.5	-0.4	-0.4
25.0	40.2	Scott River at Meamber Bridge	1.8	-1.8	-3.3	0.5	-1.7	-1.2	-1.8
23.4	37.6	Scott River at Meamber Creek	2.1	-2.0	-4.0	0.6	-2.6	-1.9	-2.0
21.5	34.6	Scott River at USGS Gage	1.3	-1.2	-3.5	0.9	-2.3	-1.2	-1.2
18.6	30	Scott River at Jones Beach	1.0	-0.4	-3.7	1.6	0.1	-1.9	-0.4
15.8	25.4	Scott River below Canyon	1.3	1.3	-1.7	2.7	1.5	1.2	1.3
14.2	22.9	Scott River below Kelsey Creek	1.4	1.2	-2.4	3.2	1.4	0.5	1.2
13.3	21.4	Scott River at Deep Creek	1.5	1.0	-2.7	3.1	1.5	-0.7	1.0
10.8	17.4	Scott River at Townsend Gulch	1.2	0.8	-2.4	2.8	1.3	-0.7	0.8
8.0	12.9	Scott River Below George Allen Gulch	0.8	0.5	-1.4	2.3	1.2	0.4	0.5
4.7	7.5	Scott River below Big Ferry Creek	0.8	-0.3	-2.8	1.6	0.2	-1.0	-0.3
3.1	5	Scott River below Mill Creek	0.6	-0.4	-1.9	0.7	-0.2	-0.5	-0.4
2.3	3.7	Scott River below Franklin Gulch	0.8	-0.7	-2.2	0.9	-0.6	-0.5	-0.7

A positive value indicates the model underpredicted, a negative value indicates the model overpredicted

Table 4.6B: Model validation results: July 28-Aug 1, 2003									
River Mile	**River Kilometer**	**Site**	**Mean Absolute Error (C)**	**Average Bias (C)**	**Minimum Bias (C)**	**Maximum Bias (C)**	**Average Bias - Daily Min (C)**	**Average Bias - Daily Max (C)**	**Average Bias - Daily Average (C)**
48.3	77.7	Scott River above French Creek	0.8	0.2	-1.6	2.4	-0.6	1.1	0.2
47.9	77.1	Scott River below French Creek	0.8	0.3	-1.0	2.3	-0.5	1.0	0.3
42.4	68.2	Scott River above Sweazey's Bridge	1.5	1.4	-0.6	3.8	0.1	1.8	1.4
41.8	67.3	Scott River at Sweazey's Bridge	1.9	1.9	-0.5	4.6	0.5	2.2	1.9
39.3	63.3	Scott River at Eller Lane	2.4	1.3	-2.8	5.4	0.7	0.7	1.3
35.1	56.5	Scott River at Island Road	1.2	1.2	-0.5	2.9	0.3	1.7	1.2
32.6	52.4	Scott River above Kidder Creek	0.7	0.6	-1.0	1.6	0.2	0.6	0.6
31.9	51.3	Scott River below Kidder Creek	0.6	-0.3	-1.5	1.3	-0.7	0.2	-0.3
25.0	40.2	Scott River at Meamber Bridge	1.4	-1.4	-2.7	0.4	-1.9	-0.3	-1.4
23.4	37.6	Scott River at Meamber Creek	2.2	-2.2	-4.2	0.2	-2.7	-0.8	-2.1
21.5	34.6	Scott River at USGS Gage	1.7	-1.7	-3.2	0.3	-2.5	-0.7	-1.7
18.6	30	Scott River at Jones Beach	0.9	-0.8	-2.3	0.7	-0.6	1.1	0.2
15.8	25.4	Scott River below Canyon	0.5	0.4	-0.7	1.2	0.3	-0.1	0.4
14.2	22.9	Scott River below Kelsey Creek	0.6	0.5	-1.0	1.4	0.4	0.3	0.5
13.3	21.4	Scott River at Deep Creek	0.8	0.5	-1.3	1.5	0.6	-0.2	0.5
10.8	17.4	Scott River at Townsend Gulch	0.9	0.8	-0.8	1.6	0.9	-0.2	0.8
0.5	0.81	Scott River at Roxbury Bridge	0.8	0.7	-0.3	1.7	-0.6	1.1	0.2

A positive value indicates the model underpredicted, a negative value indicates the model overpredicted

Table 4.7: 5-day average temperatures at monitored sites along the Scott River, given current and potential vegetation conditions

Stream Kilometer	Site name	Potential	Current (*C)	Difference (*C)	Difference (*F)
77.7	Scott River above French Creek	19.3	20.4	1.1	2.0
77.1	Scott River below French Creek	19.0	20.3	1.3	2.3
68.2	Scott River above Sweazey's Bridge	16.2	20.2	4.0	7.2
67.3	Scott River at Sweazey's Bridge	16.7	21.0	4.3	7.8
63.3	Scott River at Eller Lane	18.0	21.7	3.7	6.7
56.5	Scott River at Island Road	19.1	22.9	3.8	6.8
52.4	Scott River above Kidder Creek	19.5	23.2	3.8	6.8
51.3	Scott River below Kidder Creek	21.2	23.3	2.1	3.8
40.2	Scott River at Meamber Bridge	22.2	23.3	1.1	2.0
37.6	Scott River at Meamber Creek	21.9	22.5	0.5	0.9
34.6	Scott River at USGS Gage	21.9	22.7	0.9	1.6
30	Scott River at Jones Beach	22.1	23.5	1.4	2.5
25.4	Scott River below Canyon	20.8	22.5	1.7	3.1
22.9	Scott River below Kelsey Creek	20.9	22.4	1.6	2.8
21.4	Scott River at Deep Creek	21.2	22.7	1.6	2.8
17.4	Scott River at Townsend Gulch	21.3	22.8	1.5	2.7
0.8	Scott River at Roxbury Bridge	23.0	24.0	1.0	1.8

Table 4.8: South Fork Scott River temperature model calibration and validation results.

Date	Mean Absolute Error (C)	Average Bias (C)	Minimum Bias (C)	Maximum Bias (C)	Average Bias - Daily Min (C)	Average Bias - Daily Max (C)	Average Bias - Daily Average (C)
July 26 - July 31, 2003	0.3	0.05	-1.4	0.9	-0.3	0.3	-0.2
Aug 28 - September 10, 2003	1.0	1.0	-0.3	3.7	-0.5	-1.3	-1.0

A positive value indicates the model underpredicted, a negative value indicates the model overpredicted

Table 4.9: East Fork Scott River temperature model calibration results							
Site	**Mean Absolute Error (C)**	**Average Bias (C)**	**Minimum Bias (C)**	**Maximum Bias (C)**	**Average Bias - Daily Min (C)**	**Average Bias - Daily Max (C)**	**Average Bias - Daily Average (C)**
East Fork at Lower Masterson Road	1.2	-0.4	-1.9	3.2	-0.8	1.4	0.4
East Fork at Callahan	2.5	-2.5	0.0	4.4	2.5	3.3	2.0

A positive value indicates the model underpredicted, a negative value indicates the model overpredicted

Table 4.10: Performance of Houston / Cabin Meadows Creek temperature model.							
Site	**Mean Absolute Error (C)**	**Average Bias (C)**	**Minimum Bias (C)**	**Maximum Bias (C)**	**Average Bias - Daily Min (C)**	**Average Bias - Daily Max (C)**	**Average Bias - Daily Average (C)**
Cabin Meadows Creek downstream of 41N03	0.5	0.0	-1.0	1.3	-0.2	-0.5	0.0
Cabin Meadows Ck upstream of Houston Ck	0.6	0.6	0.0	1.2	0.8	0.8	0.6
Houston Ck downstream of Cabin Meadows Ck	0.3	0.3	-0.1	1.0	0.2	0.7	0.3
Houston Ck upstream of Little Houston Ck	0.2	0.0	-0.9	0.4	0.1	0.0	0.0
Houston Ck downstream of Little Houston	0.2	0.1	-0.6	0.5	0.2	0.2	0.1
Houston Ck upstream of Crater Ck	-1.1	1.9	0.6	0.1	-0.4	0.2	0.1

A positive value indicates the model underpredicted, a negative value indicates the model overpredicted

Table 4.11 Constants used to develop microclimate depictions

	95% Canopy Forest	**Microclimate 1**	**Microclimate 2**	**Microclimate 3**
Wind Multiplier	0.8	1.1	1.2	1.3
Relative Humidity Multiplier	1.1	0.9	0.8	0.7
Air Increase/Decrease	-2	1	2	4

Table 4.12: Summary of stream lengths in shade classes for current and desired vegetation conditions

Shade Class	Stream Length - Current Vegetation Conditions				Stream Length - Desired Vegetation Conditions			
	(miles)	(km)	% Shadier	% of Total	(miles)	(km)	% Shadier	% of Total
0-1	141	227	77.9%	22.1%	33	53	94.8%	5.2%
>1-2	73	117	66.6%	11.3%	29	46	90.3%	4.5%
>2-3	57	91	57.7%	8.8%	26	43	86.2%	4.1%
>3-4	78	126	45.4%	12.3%	36	58	80.5%	5.7%
>4-5	97	157	30.2%	15.2%	43	69	73.9%	6.7%
>5-6	127	204	10.3%	19.9%	76	122	62.0%	11.9%
>6-7	52	83	2.3%	8.1%	103	165	45.9%	16.0%
>7-8	10	17	.6%	1.6%	177	284	18.3%	27.6%
>8-9	3	5	.2%	0.5%	116	186	.2%	18.1%
>9-10	1	2	.0%	0.2%	1	2	.0%	0.2%
Total:	639	1028			639	1028		

% Shadier refers to the percentage of stream length shadier than the upper bound of the corresponding shade class

Table 5.10 Comparison of the Coho Recovery Strategy, Incidental Take Permit, Strategic Action Plan, and TMDL Action Plan[1]				
Topic	**Coho Recovery Strategy's Recovery Recommendations**	**Incidental Take Permit Application's Avoidance, Minimization, and Mitigation Measures**	**Strategic Action Plan's Strategic Actions**	**TMDL Action Plan's Implementation Actions**
Players	• California Department of Fish and Game (CDFG).	• Siskiyou Resource Conservation District (SRCD). • California Department of Fish and Game (CDFG). • Sub-permittees (primarily landowners in the Scott River watershed conducting water diversion and/or livestock management activities).	• Scott River Watershed Council (SRWC).	• The North Coast Regional Water Quality Control Board (RWB). • Various responsible parties in the Scott River watershed.
In-stream Habitat Improvement	• Improve spawning gravel quantity and quality. • Identify methods for increasing habitat complexity and appropriate locations for instream habitat structures. • Evaluate the use of beaver ponds and other efforts. • Implement projects that improve stream geomorphology in conjunction with system-wide stream channel improvement.	• The SRCD shall identify, design, and install spawning area enhancement structures in areas where spawning gravels are not plentiful. • The SRCD shall install 20 in-stream structures, such as large woody debris and boulder structures to improve pools and cover.	• Evaluate the relationship of riparian conditions to fish habitat. • Evaluate the geomorphology of the mainstem Scott River to identify potential restoration projects. • Evaluate locations where the channel can connect to floodplain without negatively impacting existing land uses. • Establish artificial beaver dams where appropriate.	
Fish Rescue	• Several actions, including evaluating fish rescue program.	• The sub-permittee shall provide reasonable access to CDFG for fish rescue operations.	• Evaluate results and monitor success of fish rescue program.	
Fish Passage	• Several actions, including investigating opportunities to construct low-flow channels through alluvial fans to improve fish passage.	• The sub-permittee shall modify or replace diversion structures to allow for fish passage. • The SRCD shall modify or replace at least 5 diversion structures per year (35 – 40 existing structures currently impede fish passage). • The SRCD shall install a fish ladder at the Scott Valley Irrigation District diversion head to provide for juvenile coho passage. • The SRCD shall install a boulder weir and improved head works at Farmers Ditch. • The SRCD shall develop a project to provide fish passage over an existing pond on Rail Creek.	• Identify existing fish passage structures and their locations. • Evaluate success of fish passage structures. • Perform barrier inventories of each stream with anadromous habitat.	
Fish Screens	• Several actions, including screening all diversions in the known and potential range of coho salmon.	• The sub-permittee shall fit each water diversion structure with an appropriate fish screen. • The sub-permittee shall use and maintain fish screens.	• Several actions.	
Other Fishery Issues	• Several actions, including coho salmon population monitoring and assessment.		• Several actions.	

Table 5.10
Comparison of the Coho Recovery Strategy, Incidental Take Permit, Strategic Action Plan, and TMDL Action Plan[1]

Topic	Coho Recovery Strategy's Recovery Recommendations	Incidental Take Permit Application's Avoidance, Minimization, and Mitigation Measures	Strategic Action Plan's Strategic Actions	TMDL Action Plan's Implementation Actions
Water Use & In-stream Flow	• Determine unused diversion rights and approach those diverters about providing flows for instream use without impacting the water rights of others. • Seek funding to conduct studies on flow-habitat relationships. • Provide process for the donation, selling, or leasing of water or water rights for in-stream flow. • Ask the SRWC to develop a Dry Year Water Plan. • Add additional oversight to verify water use and better manage water in watermaster service areas. • Support the Scott River Water Trust. • Prepare a comprehensive study to determine current status of groundwater in the Scott Valley and its relationship to surface flows. • Study the correlation of stream flow with other parameters to closely predict weekly flow rates (cfs). • Prior to groundwater study completion, recommend County establish process for developing groundwater management plans. • Several other actions.	• The sub-permittee shall install head gates and/or devices to measure/control diverted water. • The SRCD shall install at least 5 head gates and/or devices to measure/control diverted water per year (40 active diversions are currently in need of such structures). • The sub-permittee shall adhere to water rights. • The SRCD shall develop a water diversion verification method (e.g., watermaster service). • The SRCD has requested the permit include a condition that any measure specified in the permit be modified so as to eliminate any significant risk of a sub-permittee losing a portion or all of their water right if such a risk should exist. • In French and lower Shackleford creeks, the sub-permittee shall make diverted water usually used for agricultural purposes available for in-stream flow if connectivity with the Scott River is about to be broken prior to June 15. The SRCD shall pay the sub-permittee for the otherwise diverted water that is used for in-stream flow. • The SRCD shall develop the necessary legal steps and funding sources to allow for payments to sub-permittees for the otherwise diverted water that is used for in-stream flow. • The SRCD shall work with CDFG and water users to develop an water-saving solution to Fay Ditch, with saved water going to in-stream flow. • The RCD shall develop and implement a contingency plan for dry and critically dry water years. • The SRCD shall work with sub-permittees diverting water for livestock to minimize the amount of water diverted. • The SRCD shall install an average of 3 livestock water systems per year that use groundwater instead of surface water, with saved water going to in-stream flow.	• Working on the development of a groundwater study. • Evaluate the ground and surface water recharge effects of irrigation ditches. • Evaluate potential domestic/urban water use. • Investigate feasibility and effectiveness of various water recharge methods. • Investigate water storage opportunities. • Where feasible, install systems that reuse tail or end water or percolate it through the ground to cool it. • Encourage awareness that water use should not exceed adjudicated amounts. • Facilitate compliance with water rights. • Investigate the possibility of temporarily dedicating water for in-stream flow during emergency situations. • Identify products/goods which are less water intensive, develop handbook, and work with landowners to promote use of products. • Develop a manual to educate users about potential water conservation practices. • Investigate opportunities for upland vegetation management in the watershed to enhance water supply and timing.	• The RWB encourages water users to develop and implement water conservation practices. • The RWB requests the County of Siskiyou to study the connection between groundwater and surface water, the impacts of groundwater and surface water use on beneficial uses, and the impacts of groundwater levels on the health of riparian vegetation. • Should the County determine that it is able to commit to conducting the study, the County shall develop a study plan within 1 year of the date the TMDL Action Plan is approved.
Riparian Fencing & Planting	• Encourage riparian restoration and projects using locally native vegetation. • Continue riparian easement programs. • Educate non-agricultural landowners on the importance of not removing riparian vegetation. • Promote and encourage protection of riparian zones through fencing and other measures.	• The sub-permittee shall install riparian fencing within a schedule specified by the SRCD. • The sub-permittee shall allow riparian fencing and planting to occur on their property. • The SRCD shall develop a riparian planting program. • The SRCD shall prioritize riparian fencing and planting activities.	• Evaluate riparian planting projects and make recommendations to improve the program. • Identify, prioritize, and seek funding for riparian restoration opportunities. • Identify appropriate incentives for improving stream protection by working with agricultural users. • Develop a program for re-vegetating riparian areas in the residential dominated foothills.	• The RWB encourages the preservation and restoration of vegetation that provides shade to a water body. • The RWB shall develop and take appropriate permitting and enforcement actions to address the removal and suppression of vegetation that provides shade to a water body.
Other Temperature Issues	• Identify location, timing, frequency, and duration of thermal barriers to migration for adult and juvenile salmon.		• Identify and remedy conditions that contribute to high water temperatures. • Identify locations of thermal refugia. • Identify thermal barriers to migration. • Conduct riparian inventories. • Recommend enhancements to expand thermal refugia. • Additional actions.	• See actions listed under the Riparian Fencing and Planting category.

Table 5.10
Comparison of the Coho Recovery Strategy, Incidental Take Permit, Strategic Action Plan, and TMDL Action Plan[1]

Topic	Coho Recovery Strategy's Recovery Recommendations	Incidental Take Permit Application's Avoidance, Minimization, and Mitigation Measures	Strategic Action Plan's Strategic Actions	TMDL Action Plan's Implementation Actions
Grazing Activities	• Recommend to County to develop agricultural land use policies addressing coho salmon recovery actions, ideas, and protections.	• The sub-permittee shall ensure there is no intentional grazing of livestock within the bed, bank, or channel of the water bodies within the Scott River watershed without a grazing management plan approved and monitored by CDFG.	• Develop an information handbook and work with livestock managers on timing and movement of grazers to minimize stream impacts.	• The RWB encourages grazing-caused sediment and temperature prevention, minimization, and control. • The RWB's Executive Officer shall require Grazing and Riparian Management Plans on an as-needed, site-specific basis. • The RWB shall regulate grazing-caused sediment waste discharges and elevated water temperatures through appropriate permitting and enforcement actions. • The RWB shall work with the USFS and the BLM to develop MOUs to address sediment waste discharges and elevated water temperatures from grazing activities or the RWB shall take appropriate permitting and enforcement actions.
Roads & Other Sediment Waste Discharge Sources	• Develop a sediment budget. • Design, secure funding, and implement projects. • Identify, quantify, and remedy sources of fine sediment. • Where agricultural roads have a potential effect on coho salmon, conduct inventory, implement remediation actions, and monitor effectiveness.	• From November 1 to April 15, the sub-permittee shall cross flowing streams only at prepared crossing sites with livestock and vehicles. These crossings shall meet specific criteria (see the permit application for details). • From November 1 to April 15, for the mainstem Scott River upstream of Young's Point Dam, including the East Fork Scott River, the sub-permittee shall cross flowing streams with livestock and vehicles only when redds are found to not be present.	• Educate road users about road-related erosion problems and remedies. • Identify and correct existing road-related drainage and erosion problems. • Support the development of programs for continuous year-round maintenance of roads and bare slopes.	• The RWB encourages road-caused sediment prevention, minimization, and control. • The RWB's Executive Officer shall require Erosion Control Plans and Monitoring Plans on an as-needed, site-specific basis. • The RWB shall regulate road-caused sediment waste discharges through appropriate permitting and enforcement actions. • The RWB shall work with the County to develop a MOU to address county roads. • The RWB encourages the County to develop a grading ordinance. • The RWB shall evaluate Caltrans' state-wide Storm Water Program.
Timber Activities				• The RWB shall regulate timber-caused sediment waste discharges and elevated water temperatures through existing appropriate permitting and enforcement tools, including the general waste discharge requirements (WDRs) and the categorical waiver of WDRs. • The RWB shall work with Habitat Conservation Plan holders to develop ownership-wide WDRs. • The RWB shall work with the USFS and the BLM to develop MOUs to address sediment waste discharges and elevated water temperatures from timber activities or the RWB shall take appropriate permitting and enforcement actions.
Flood Control & Bank Stabilization	• Identify and assess effects of flood control levees.			• The RWB encourages the planting and restoration of stream banks on and around existing flood control structures. • The RWB shall use existing regulatory tools (e.g., 401 Water Quality Certifications) to ensure that flood control and bank stabilization activities minimize the removal and suppression of vegetation that provides shade to a water body.
Dredge Mining & Tailings	• Initiate study for tailing rehabilitation and water storage. • Restore the Scott River flood plain in the Callahan Dredge Tailings reach.			• The RWB shall review laws and regulations relating to suction dredge mining and investigate the impact of suction dredge mining activities on sediment and temperature loads.
Cooperative Efforts	• Several actions.		• Several actions.	• The RWB shall work cooperatively with the SRCD, the Scott River Watershed Council, the Natural Resources Conservation Service, UC Cooperative Extension, and the CDFG.
Outreach & Education	• Several actions.		• Several actions.	
Fire Issues			• Several actions.	

[1] The recommendations, measures, and actions listed in this table are (1) summarized and (2) are the recommendations, measures, and/or actions that are most directly applicable to sediment and temperatures issues in the Scott River watershed. For more detail, please refer to the document from which the recommendations, measures, and/or actions are taken.